Books are not absolutely dead things, but do contain a potency of life in them to be as active as that soul was whose progeny they are nay they do preserve as in a vial the purest efficacy and extraction of that living intellect that bred them

—*John Milton*

To

Prof RAMESHWAR SHARMA

Principal & Controller

REFACE TO THE TENTH EDITION

the last decade many new operations have me into daily use and more extensive operative ocedures have become commonplace These ve been made possible by the newer methods anæsthesia, the use of antibiotics, and blood ansfusion Although it is only five years since s book was last revised a good deal of eration has been necessary

All chapters have been amended where cessary to bring them into line with modern rgical teaching and technique There are w sections dealing with thoracic surgery, pyelosty and suprapubic cystostomy, hernia and treatment of hydrocele and spermatocele, erations on the salivary glands, and the newer hniques for dealing with hæmorrhoids and icose veins In addition I have included a v chapter on ligatures and sutures which uld prove most helpful to the student

Once again I have to thank my surgical

friends both at home and abroad for their very useful and constructive criticisms To Mr Harold Renyard of Nottingham I owe a special debt *of gratitude for he has been of the greatest* assistance to me in revising this book while he was Senior Surgical Tutor at King's College Hospital

My thanks are also due to the publishers for their unfailing courtesy and help

I feel sure that this new edition will prove of value to the senior student, the house surgeon and to those working for higher examination in surgery

CECIL WAKELEY

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LONDON, W 1

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PART I—LIGATURE OF ARTERIES

CHAPTER I

GENERAL CONSIDERATIONS

Note —The reader is urged to study this chapter carefully before those describing the ligature of any particular artery it contains important directions which apply to practically all such operations

Indications.—The indications for exposure and ligature of arteries may be summarized as follows

1 In cases of hæmorrhage, where the exposure may be local or remote
2 In the treatment of aneurysms
3 In cases of embolus preparatory to embolectomy
4 For the purposes of sympathetic denervation
5 To diminish the blood supply to an organ, e g lingual artery and thyroid vessels
6 To diminish the blood supply to tumours e g certain vascular nævi
7 As a convenient first step in some amputations especially where a tourniquet cannot be applied —e g hip and shoulder joints
8 In certain congenital abnormalities of the heart and great vessels
9 As an examination exercise

Instruments required —Scalpel two pairs of forceps ordinary dissecting one and a fine toothed pair, small blunt hooks, retractors long toothed forceps pressure forceps aneurysm needle ligatures a blunt pointed dissector

Small blunt hooks with long shafts are most convenient as retractors especially to draw nerves and tendons out of the way

There is considerable choice in the form of ligature used the most essential points being (*a*) that it should be strong enough without being cumbrous or too rigid (if chromicized catgut be used it may cut through the wall of an artery or vein like wire) (*b*) that it should be resistant enough to last as a firm knot for at least ten days or so and (*c*) that it should be perfectly aseptic when introduced into the tissues

Catgut silk and stout linen thread of medium thickness may all be recommended

In preparing for the operation the ligatures should be allowed to soak for ten minutes or so in sterilized water at a temperature below 100° Fahr and should then be tested as to strength For temporary or trial ligature of large arteries a broad piece of sterilized tape is useful

Position of the patient —The position of the patient will vary a little according to the artery to be tied In general terms it may be said that the surgeon should stand upon the side to be operated on and that the incision on the right side is more conveniently made from above downwards and on the left side from below upwards

Steps of the operation —These will be considered the following order —

1 The line of the artery
2 The incision
3 The exposure of the artery
4 The opening of the sheath
5 The passing of the ligature

1 *Line of the artery* —As a rule the line laid down the textbooks of anatomy for each artery is followed by operator in making his incision Now and then as in case of ligature of the brachial at the bend of the elbow the incision is best made to cross this line obliquely still more so in ligature of the external iliac

The posture of the limb is of moment In indicating the exact situation of the femoral or brachial arteries for

instance it is essential that the limb should be placed in a certain position before the line is drawn Depressing the shoulder well is essential during ligature of the subclavian

2 *Incision* —In many situations, superficial veins are met with in cutting down on the artery, they should be divided between two ligatures It is most desirable that there should be little bleeding during the operation, that the wound should

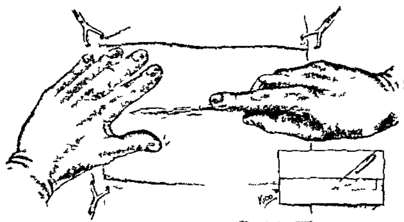


Fig 1 —The correct way to make an incision

The left hand stretches the skin The blade is held at right angles (not obliquely) to the stretched skin and is entered at once to the full depth and kept at this level for the whole length of the incision The knife must not become more superficial as the incision proceeds

be dry ' and the view of the depths not embarrassed by pressure forceps

The scalpel should be held in what is termed the dinner knife position (Fig 1) The wound should be freely made and cleanly cut There is a disposition to make the incision too small A small wound carries with it special dangers and difficulties whereas a moderate increase in the length of the skin cut does not add to the gravity of the procedure

The knife should be entered at right angles to the surface,

and should be in the same position when withdrawn The surface wound should be of equal depth throughout There should be no tails to the cut

The skin should be steadied and stretched with the lef hand while the integuments are being divided

After the surface cut has been made the next step is t divide the deep fascia or aponeurosis This is done by clean cut made in the line of the original incision and carrie the whole length of the wound

A director is not required either at this or at any othe stage of the operation In the ligature of arteries the directo should be avoided as an unnecessary and dangerous weapo

When the deep fascia has been exposed in a limb, th outlines of the underlying muscles and tendons are rendere more or less distinct It is important to identify each lanc mark often the edge of a muscle before going deeper Thu in ligature of the femoral artery in Hunter's canal it essential to define the outer edge of the sartorius muscle i ligature of the brachial artery in the mid arm to define th biceps edge and then the median nerve (after division of th fascia)

The deep part of the wound should follow the line of th superficial incision and should equal it in extent The woun should not be funnel shaped

Care must be taken in retracting the parts overlying th artery the operator himself must place the retractors an the assistant should use light and even pressure with then Injudicious retraction often causes trouble and difficult in exposing the artery

All bleeding must be checked as it is encountered Th wound should be kept dry to its very bottom

Above all things the operation must be conducted ste by step Each guiding point must be well made out befor the next point is sought

3 *Exposure of the artery* —The artery should be sough with the finger This of course does not imply that th fingers should be used roughly in opening up the wound a fault far too often seen during examination operation

As the tissues may be more or less evenly stained with blood, the finger—in a deep wound especially—affords the best means of differentiating the artery, the veins, and a companion nerve.

To the touch the nerves feel firm, resistant, round, and cord-like; they cannot be flattened by the pressure of the finger. The veins greatly exceed the corresponding arteries in size; they often overlap those vessels; they feel soft and yielding and thin walled; they are easily compressed, and when so treated swell out upon the distal side. When the finger touches the compressed vein the vessel as a tube can scarcely be appreciated. In this respect it is very different from the artery. The artery feels firmer and more elastic. It is not unlike a thin indiarubber tube to the touch; it is movable and often slips about under the finger in a characteristic manner. It can be compressed, but not so readily as the vein. When flattened out by the finger an artery of moderate dimensions feels like a flat band or thong, thick and elastic, and hollowed out a little in the centre, so that the margins feel thicker than the median part. Above all, it pulsates in the living subject.

There are many fallacies in this pulsation. The throbbings of the artery may be transmitted to the nerve (as in the case of the median nerve and the brachial) or to the companion vein. When the patient is under an anæsthetic, and when the pulse is feeble or very rapid, the movement in the artery may be difficult to detect. If an aneurysm or a pulsating growth exists, compression of the artery causes the pulsation in the tumour to cease.

There may be one companion vein or two—the venæ comites. All arteries below the knee are accompanied by venæ comites. All arteries of the arm, forearm, and hand are attended in like manner.

The arteries of the trunk which are of small or of medium size are *for the most part accompanied by venæ comites*. Such are the internal pudendal, the deep epigastric, the deep circumflex iliac, and the internal mammary.

The arteries in the head and neck are attended by single

veins the only noteworthy exception to this being the ling artery

The venæ comites lie close to the artery one upon e side of it They are apt to communicate with one anot freely across the vessel by means of many transve branches

4 *Opening the sheath* — The artery is now reach It remains to open the sheath and to clear a part of vessel for the passage of the aneurysm needl

The sheath must be opened with the scalpel with infir care and the most delicate precision The knife must h a perfect cutting edge A good light is essential and n and then an electric head lamp will be found useful in tying one of the iliac arteries To pick up the she there is nothing better than the fine toothed forceps, tl grasp a fold of the tissue securely whilst the ordinary forc take up too much or are apt to let it slip

The sheath is picked up over the *centre* or median p of the artery in the form of a fold which is *transverse* to long axis of the vessel It must be picked up cleanly a entirely The transverse fold of the sheath is then incis The cut should be clean should be made in the *long axis* the artery and over the *centre* of the vessel In leng it should be from 5 to 10 mm When the sheath has l well divided the serous like space between it and the art becomes at once evident The blade of the scalpel sho be inclined obliquely—i e with the flat of the knife towa the artery

The fold of the sheath must be held well up du the making of the incision The end of the blunt disse is now insinuated inside the sheath between the for and the artery and is made to push the artery very ge away from its sheath until one half of the vessel s circ ference is cleared Taking up the other side of the s incision into the sheath one carries out a similar manœu thus an easy path is made for the aneurysm needle

5 *Passing the ligature* —The sheath having thus detached from the artery all round it transversely bu

[a] very short distance as regards its length the surgeon [intr]oduces the aneurysm needle between the artery and the [sh]eath The needle should be held with its concavity to[w]ards the vessel and it should be gently insinuated round [the] artery, being passed from that side of the opening held [u]p by the forceps

On no account must any force be used, either in clearing [th]e artery with the blunt dissector or in gliding the end of [th]e aneurysm needle beneath and around the vessel It [oft]en happens that some tissue covering the needle point [as] it emerges requires to be drawn aside with the toothed [for]ceps If the needle *does not pass easily, it is best to with[dr]aw* it and to repeat the manœuvre with the blunt dissector [Th]e needle is now threaded, and withdrawn carrying the [lig]ature with it

About one centimetre of the artery more or less, is cleared [Th]e needle should be kept throughout at right angles to the [axis] of the vessel It should rarely be passed threaded

It is the usual practice to pass the needle from the most [vu]lnerable adjacent structure usually the vein A more [im]portant rule is to pass the needle from the forceps it is [oft]en more convenient to pass it towards the vein If the [sh]eath has been well opened and a way for the ligature [car]efully cleared around the artery, there can be little excuse [for] forcing the point of the needle through the sheath into [th]e companion vessel *The aneurysm needle must of course* [be] really blunt pointed

When venæ comites attend a deep artery of moderate [siz]e such as the ulnar or posterior tibial, much time may [be] wasted and damage done by a determined attempt to [se]parate the artery from the veins, this is especially the case [wh]en many transverse connecting branches pass across the [ar]tery In such instances practice has shown that no evil [re]sults from including the two veins in the ligature In dealing [wi]th still smaller arteries such as the lingual no attempt [is] made to avoid including the companion veins in the [lig]ature

In tying these smaller arteries, e g the lingual or radial,

of course it is not necessary to follow the elaborate directions given above as to passing the aneurysm needle inside the sheath But in the case of the larger vessels these precise rules will be found of the greatest use Precision neatness gentleness are all requisite if mistakes and accidents are to be avoided in fact in few operations are they more essential than in ligature of main arteries

It is needless to say that the greatest care must be taken to avoid including a nerve in the ligature If the sheath be well opened and the needle be kept close to the artery and be passed round with ease there is little danger of including a nerve A typical example of this is found in ligature of the common carotid



Fig 2 —The figure to the right shows a reef knot that to the left [illegible] granny

The ligature should [illegible] and be tied exactly at right angles to the line of the artery The knot should be tied quietly and slowly and not with a vicious jerk

It should be sufficiently tight to rupture the inner coats Care should be taken that the vessel is not dragged out of place in the tying It is not absolutely essential for the inner coat to be ruptured in order to secure occlusion of the vessel but as a rule we advise that this shall be done

The points of the two fore fingers should meet upon the artery as the knot is being tied The knot should be a reef knot (Fig 2) not a granny It is important to cut the ends fairly long so that there shall [illegible] chance of the knot untying itself

Another form of ligature for large arteries [illegible] called [illegible] knot (Fig [illegible]) [illegible] [illegible] [illegible] and the [illegible] [illegible] the artery [illegible] and the [illegible] divided [illegible] [illegible] single knot

and the two ends on either side are then made to complete the reef knot The effect is of course to take a broad hold of the vessel double the width of the single ligature In former days a tape was used with this object In ligaturing large vessels the operator should aim at approximating the coats of the artery and avoid rupturing the walls

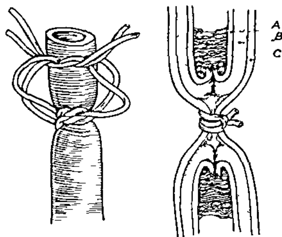


Fig 3 —Ligature of a large artery left, Ballance s stay knot right the correct effect of ligature

The intima (A) and media (B) rupture and curl up into the lumen of the vessel The adventitia (C) should not be damaged Coagulation occurs readily and extends as far as the first branch

Division of an artery between two ligatures — This is the correct procedure for a punctured wound of an artery The vessel is secured on either side of the puncture and cleared sufficiently to enable the ligature to be applied securely round both proximal and distal ends In the case of ligature of a main artery in its continuity—e g the superficial femoral for aneurysm—it has been advised in order to relieve tension and favour formation of a firm clot The expediency is doubtful If this course be adopted care should be taken to place both ligatures at an ample distance from the

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Another form of ligature for large arteries is the so called stay knot (Fig 3) A double strand of silk or catgut is passed round the vessel (always one of the main arteries) and the loop divided Each portion is tied in a single knot

and the two ends on either side are then made to complete the reef knot The effect is, of course to take a broad hold of the vessel double the width of the single ligature In former days a tape was used with this object In ligaturing large vessels the operator should aim at approximating the coats of the artery and avoid rupturing the walls

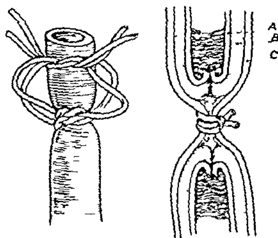


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level of section as fatal results have followed slipping of the ligature from one end

Suture of arteries and Matas' operation on aneurysms —Of recent years suture has found an increas

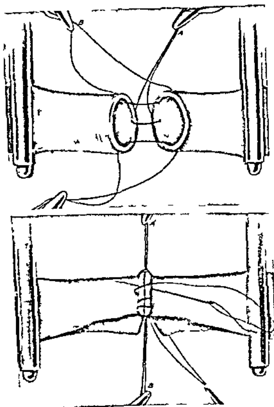


Fig 4 —End to end suture of an artery Carrel s method

The first figure shows guide sutures inserted with the rubber faced clamp in position the second shows two guide sutures pulled taut over hand suture of intervening segment of vessels

ingly important place in the surgery of arteries Excision and anastomosis of the coarcted aorta and direct pulmonary subclavian anastomosis have become two commonplace procedures Excision of aneurysm or of a segment of diseased vessel and replacement with a freeze dried graft has met with considerable success The use of immediate grafts to battle casualties in the Korean campaign prevented the onset of gangrene in many main vessels after injury Recently it has been found possible to use plastics notably orlon instead of preserved blood vessel as a graft with good results It is obvious therefore that arterial suture has an increasing scope The principles of applying the suture will be understood from Fig 4

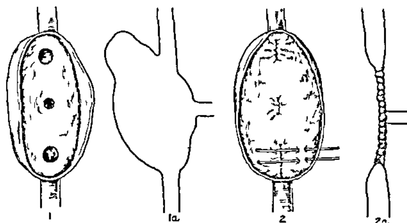


Fig 5 —Matas obliterative method (Warren)

1 Showing the opening of vessels into the sac 1a section of same 2 apertures of vessels closed 2a section of obliterated sac

1 In order to get a smooth surface the intima must be turned outwards at the line of suture

2 The clamps above and below are secured as lightly as possible and removed directly the suturing is effected

3 The finest silk and ordinary sewing needles are used, the silk is sterilized in paroleine (liquid petroleum jelly is recommended by many)

4 The less forceps are used to grasp the vessel wall the better

Obliterative aneurysmorrhaphy (one of *Matas* methods) consists in obliterating an aneurysm by suturing together the walls of the sac by means of a large number of stitches from the inside and also closing the orifices leading from the artery in the aneurysm It is illustrated in Fig 5 The method can only be employed where a tourniquet round the limb will shut off the blood stream during the operation It is quite impracticable to preserve the continuity of flow through the artery affected by Matas operation The advantages of this procedure over ligature are somewhat problematical

CHAPTER II

LIGATURE OF THE ARTERIES OF THE UPPER LIMB

Radial Artery

Line of the Artery.—A line from the centre of the bend of the elbow to the radial pulse at the wrist the artery lies between the tendon of the brachioradialis and the flexor carpi radialis

Position.—The surgeon stands on the side to be operated upon The limb is in the position of supination and is firmly held by an assistant who grasps it by the hand and by the upper arm

I Ligature in the lower third of the forearm.—An incision from 1 to 2 inches in length is made over the line of the pulse midway between, and parallel with the tendons of the brachioradialis and flexor carpi radialis muscles The cut must not reach below the level of the tuberosity of the scaphoid (Fig 6)

The commencement of the superficial radial vein usually lies over the artery in this situation and immediately under the skin It should be avoided

The fascia which is here quite thin is divided in the line of the original wound The gap between the two tendons is now made manifest Over or in close relation to the artery may be observed the terminal part of the anterior division of the radial nerve

It may be impossible to separate the venæ comites from the artery to a sufficient extent to allow the needle to pass In such case the ligature must include the veins as well as the artery (Fig 7)

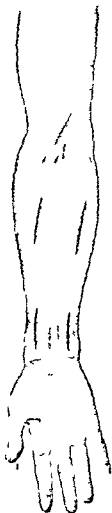


Fig 6 —Ligature of the radial and ulnar arteries and of the brachial at the bend of the elbow

Ligature in the middle third of the forearm—An incision 2 inches in length is made in the line of the artery the limb being in the position indicated The centre of the incision corresponds to the centre of the forearm (Fig 6) In cutting through the subcutaneous tissues care must be taken to avoid any superficial vein belonging to the radial or median veins

The anterior division of the musculo cutaneous nerve lies usually in the line of the artery outside the deep fascia and just beneath the superficial veins

The deep fascia is laid bare and is divided in the length of the original wound The fibres are transverse

The brachioradialis muscle is now exposed about the point where it is beginning to become tendinous The inner or ulnar border of the muscle is defined and the muscle itself is drawn outwards The elbow may be a little flexed to allow of this being done more easily

The vessel is now found lying upon the insertion of the pronator teres with which it is connected by much connective tissue The nerve may or may not be seen as it lies on *the radial side of the vessel (Fig 8)*

The venæ comites should be separated as well as possible and the needle passed from the more convenient side

Comment —As the brachioradialis is not very wide at this part (especially if the artery be sought for at the lower end of the middle third) it is very easy to expose the outer instead of the inner border of the muscle in which case the muscle is apt to be drawn inwards and when the depths of the wound are opened up the superficial branch of the radial nerve is reached This is the common error of beginners

The tendon of the brachioradialis as a rule first makes its appearance at the outer border of the muscle so that if this tendinous edge be exposed the operator will know that he has laid bare the wrong side of the muscle The inner border of the brachioradialis remains muscular until it ends somewhat abruptly in the tendon

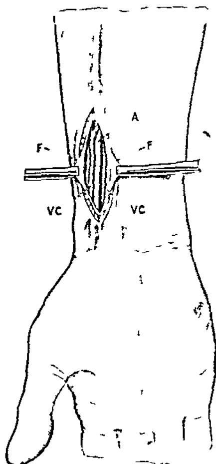


Fig 7 —Ligature of the right radial at the wrist

A Artery F fascia VC venæ comites

ULNAR ARTERY

Line of the artery —The ulnar in the lower two thirds of its course in the forearm is represented by a line drawn from the tip of the internal condyle of the humerus to the radial side of the pisiform bone

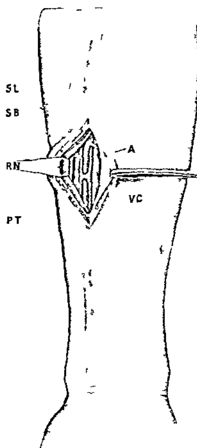


Fig 8.—Ligature of the right radial about the middle third of the forearm

SL, Sup long SB sup brevis RN radial nerve PT insertion of Pron teres VC venæ comites A artery

The upper third of the artery is too deeply placed to be exposed for ligature unless it be actually laid bare in a wound it can be marked out by a line drawn from the middle of the bend of the elbow to the junction of the upper and lower two thirds of the first line

Ligature in the middle third of the forearm —An incision from 2½ to 3 inches in length according to the muscular condition of the limb is made precisely in the line of the artery (Fig 10) Beneath the integuments the anterior ulnar vein and branches of the anterior division of the medial cutaneous nerve of the forearm are apt to be encountered The deep fascia is thin and is divided in a line parallel with but a little to the outer side of the line of the skin incision

The surgeon now seeks for the gap between the flexor carpi ulnaris muscle and the flexor sublimis

digitorum (Fig 11) The position of this interval is sometimes indicated by a white line The gap is however best demonstrated by the touch the left fore finger being used for the purpose As soon as the inter muscular space has been made evident the wrist is a little flexed to relax the mus les The flexor carpi ulnaris is now drawn inwards by means of a broad bladed retractor The flexor sublimis is in like manner drawn a little out wards The surgeon opens up the vertical inter muscular space thus demonstrated and at the bottom of it will probably first be found the ulnar nerve To the outer side of the nerve is the artery Both structures run between the super ficial and deep flexors as shown in Fig 11 The fascia

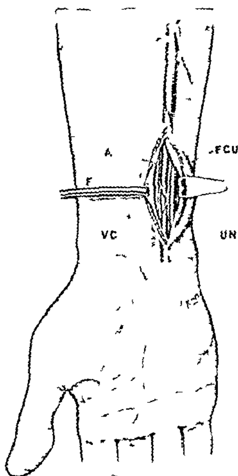


Fig 9 —Ligature of the right ulnar at the wrist

A Artery F fascia VC venae comites UN ulnar nerve FCU flex carpi ulnaris tendon

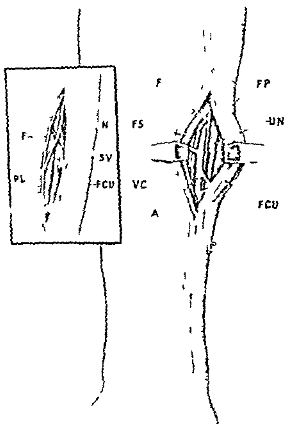


Fig 10—Ligature of the right ulnar at the middle third of the forearm

F Fascia FS flex sublis [illegible] VC venae comites A artery FCU flex carpi ul[illegible] UN ulnar nerve FP flex profundus

(*Inset*) F Fascia PL palma[illegible] longus FCU flex carpi ulnaris SV superficial vein N ulnar nerve

binding down the vessels in this situation is slender There is usually no difficulty in separating the artery from its venæ comites

The needle should be passed from within outwards so as to avoid the nerve

Comment—This operation is associated with considerable difficulty if carelessly performed and the procedure is surrounded by many possibilities of error

Fig 11 —Transverse section of the forearm diagrammatic, to show the intermuscular spaces about the middle third

Initials indicate the tendons and muscles *a* Ulnar artery interspace *b* interspace to be avoided *x* surgical line of ulnar artery 1 ulnar vessels 2 radial vessels 3 median nerve

The chief difficulty is to demonstrate the gap between the flexor carpi ulnaris and flexor sublimis muscles

The white line which is said to mark this gap is not to be relied upon

The interspace between the two muscles in question is not quite straight i e is not quite vertical when the limb is in position for operation The flexor carpi ulnaris overlaps the flexor sublimis a little and the line of the interspace is directed as is shown at *a* in Fig 11 The fibres of both the muscles follow the long axis of the limb

If the division of the deep fascia be exactly in the line of

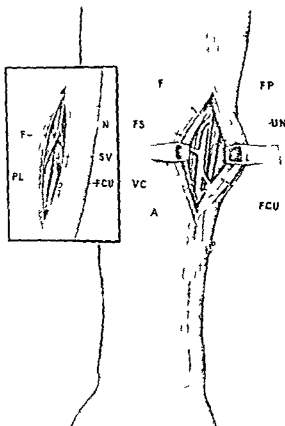


Fig 10 —Ligature of the right ulnar at the middle third of the forearm

F Fascia FS flex sublimis VC venae comites A artery FCU flex carpi ulnaris UN ulnar nerve FP flex profundus

(*Inset*) F Fascia PL palmaris longus FCU flex carpi ulnaris SV superficial vein N ulnar nerve

the skin incision i e in the line of the artery, x (Fig 11) the knife will probably cut upon the flexor carpi ulnaris

By dividing the fascia a little more to the outer side, as advised the knife comes upon the flexor sublimis (Fig 11) and by working inwards the oblique gap between the muscles is made out This gap is always best demonstrated by the finger It is often indicated by one or more cutaneous arteries which escape here and form an excellent guide to the main artery The interspace should be sought for at the lower part of the wound and the separation of the two muscles should take place from below upwards

In muscular subjects care should be taken that the incision is made long enough

When the proper interval has been found between the flexor sublimis and the flexor carpi ulnaris it is not uncommon for the beginner—impressed with erroneous views as to the depth of the artery—to proceed too deeply and too far to the inner side and actually to pass by the ulnar nerve and open up the interspace between the flexor carpi ulnaris and the flexor profundus digitorum (*See b* Fig 11)

This may readily happen if the former muscle be dragged too much to the inner side

Note —If it is necessary to secure the arteries higher up to stop secondary hæmorrhage from wounds of the palm ligature of the brachial should always be preferred to that of the radial and ulnar together

Brachial Artery

Line of the artery — When the arm is extended and abducted with the hand supine the brachial artery corresponds to a line drawn from the outlet of the axilla (at the junction of its middle and anterior thirds) to the middle of the bend of the elbow i e the mid point between the two epicondylar projections

Position —In securing the artery at the bend of the elbow, the limb extended and abducted may be allowed to rest upon the olecranon It should not be over extended

In dealing with the vessel in the arm the limb should be extended and abducted with the hand supine and should be held away from the body The arm itself should not be supported in any way, but the limb should be held by the forearm by an assistant

The surgeon may make the incision from above downwards on both sides of the body standing to the outer side of the limb on the right side and between the trunk and the limb on the left side Or on the left side the operator may place himself to the outer side of the limb and bending over it may make the incision from below upwards

Ligature at the middle of the arm —The limb having been placed in the position indicated (*see* p 20) an incision about $2\frac{1}{2}$ inches in length is made along the inner edge of the biceps muscle in the line of the artery (Fig 14)

The fascia which is here thin is exposed and divided and the muscular layer is reached It is extremely important that the inner margin of the biceps be clearly exposed and surely identified The muscle is

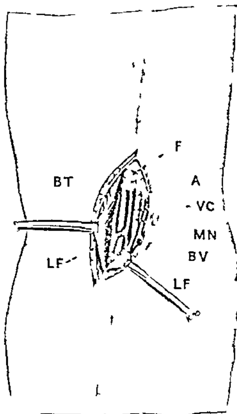


Fig 12 —Ligature of the right brachial at the bend of the elbow
F fascia A artery VC venæ comites MN median nerve BV basilic vein LF bicipital fascia BT biceps tendon

the skin incision i e in the line of the artery, x (Fig 11) the knife will probably cut upon the flexor carpi ulnaris

By dividing the fascia a little more to the outer side, as advised the knife comes upon the flexor sublimis (Fig 11), and by working inwards the oblique gap between the muscles is made out This gap is always best demonstrated by the finger It is often indicated by one or more cutaneous arteries which escape here and form an excellent guide to the main artery The interspace should be sought for at the lower part of the wound and the separation of the two muscles should take place from below upwards

In muscular subjects care should be taken that the incision is made long enough

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Line of the artery — When the arm is extended and abducted with the hand supine the brachial artery corresponds to a line drawn from the outlet of the axilla (at the junction of its middle and anterior thirds) to the middle of the bend of the elbow i e the mid point between the two epicondylar projections

Position.—In securing the artery at the bend of the elbow, the limb extended and abducted, may be allowed to rest upon the olecranon It should not be over extended

more glaring mistakes are made than occur in the course of searching for this superficial vessel

In the first place, the arm should be unsupported and be at right angles to the trunk If the arm be allowed to rest upon a table the triceps will be pushed forwards and may be then mistaken for the biceps while the ulnar nerve has been mistaken for the median This observation especially applies to the middle third of the limb

The vessel is mobile and is easily displaced and in drawing the biceps aside roughly with a retractor the vessels and the median nerve have been withdrawn from the field of the operation and possibly the ulnar nerve brought into view The operator must himself place the retractor before giving it to his assistant to hold The clear identification of the biceps margin is essential The advice sometimes given that the 'sheath of the muscle' should not be opened is neither sound nor very precise

The pulse in the brachial is often much feebler than would be imagined and this is especially the case in dealing with severe hæmorrhage The pulsation may be so clearly transmitted to the median nerve that that nerve has been mistaken for the artery

It is asserted that the basilic vein has been mistaken for the artery Tillaux states that a large superior ulnar collateral artery has been taken for the brachial

If the incision be made too much to the inner side of the proper line the basilic vein may be wounded especially when it is superficial i e in the lower segment of the arm

In very muscular subjects the biceps may overlap the artery considerably In some instances (one in eight according to R Quain) the brachial bifurcates above the elbow perhaps as high as the axilla Two arteries running side by side may then be found in the mid arm the smaller and more superficial of the two ending below in the radial

displaced a little outwards and the pulsation of the vessel is sought A little dissection exposes the median nerve —it if be not already in view (Fig 13) In the middle of the arm the nerve usually lies in front of the artery In applying a ligature to any part of the brachial at or above the middle of its course the nerve should be drawn outwards If the brachial be exposed below the middle section the nerve is more conveniently displaced inwards

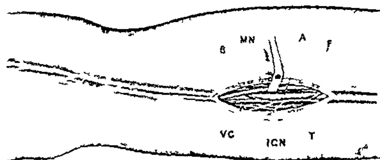


Fig 13 —Ligature of the right brachial at the middle of the arm

A Artery B biceps F fascia ICN int cutaneous nerve MN median nerve VC venæ comites

While the artery is being exposed the elbow may be flexed for a moment

The sheath of the artery having been opened and the venæ comites separated as well as possible the needle is passed from the nerve The inner of the two companion veins is usually much the larger

In the upper part of its course the inner margin of the coraco brachialis muscle is exposed in the place of the biceps and the ulnar nerve is lying to the inner side of the vessel

Comment —This artery is by no means so easy to ligature as might be thought and in an operative surgery class no

the centre of the incision is about opposite to the centre of that bone

The skin platysma supra clavicular nerves and fascia are divided in the first incision At the outer end of the wound

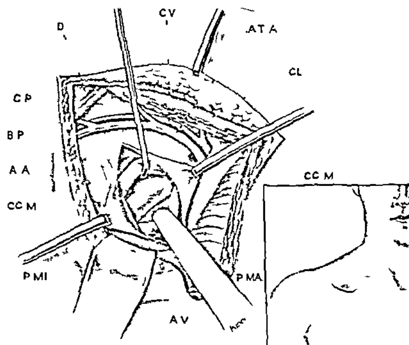


Fig 15 —Ligature of the axillary (first part)

D Deltoid muscle C V cephalic vein AT A acromiothoracic artery CL clavicle CC M costo-coracoid membrane P MA pectoralis major muscl A V axillary vein P MI pectoralis minor muscle A A axillary artery B P brachial plexus C P coracoid process

care must be taken not to injure the cephalic vein and the large branch of the acromiothoracic artery

The cephalic vein should be exposed and forms a useful guide to the artery

The outer edge of the *pectoralis major is divided* through its entire thickness close to the clavicle and to the full

AXILLARY ARTERY

Line of the artery —With the arm abducted and externally rotated the direction of the artery is shown by a line joining the mid point of the clavicle with the outlet of the axilla at the junction of the anterior with the middle third of the line connecting the anterior and posterior axillary folds

1 **Ligature of the first part** —The patient lies upon the back close to the margin of the table with the upper

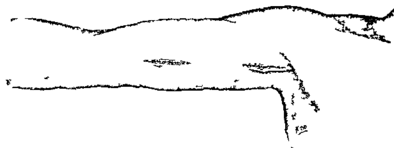


Fig 14 —Ligature of the brachial about the middle of the arm and of the third part of the axillary artery

part of the body raised The point of the shoulder should be carried well back and to effect this a hard cushion may be placed between the scapulæ The arm is allowed to lie by the patient s side It must not be dragged upon so as to depress the point of the shoulder

The operator should stand upon the outer side of the limb near the patient s trunk when dealing with the left side and near the head when dealing with the right A good light is necessary an electric head lamp being often useful

A slightly curved incision 3 inches in length with the convexity downwards is made across the infraclavicular fossa It passes about half an inch below the clavicle and

the centre of the incision is about opposite to the centre of that bone

The skin platysma supra clavicular nerves and fascia are divided in the first incision At the outer end of the wound

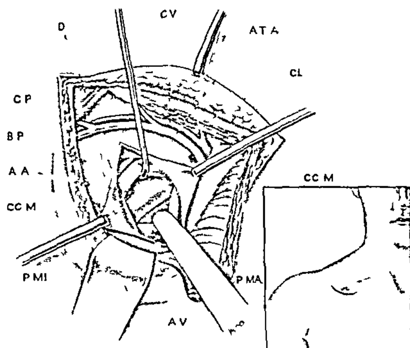


Fig 15 —Ligature of the axillary (first part)

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care must be taken not to injure the cephalic vein and the large branch of the acromiothoracic artery

The cephalic vein should be exposed and forms a useful guide to the artery

The outer edge of the pectoralis major is divided through its entire thickness close to the clavicle and to the full

extent of the original wound The upper edge of the pectoralis minor should be defined and may be drawn down if necessary

The costo coracoid membrane must now be dealt with It must not be torn through but should be divided vertically near to the coracoid process The cephalic vein if well brought out will indicate the position of the axillary vein

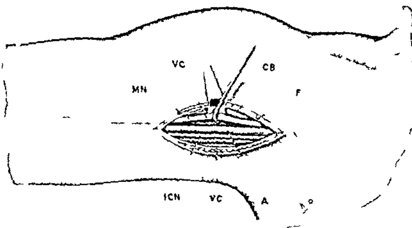


Fig 16 —Ligature of the third part of the right axillary

A Artery CB coraco brachialis F fascia ICN int cutaneous nerve MN median nerve VC venæ comites

which obscures the artery lying on a more superficial plane Above and to the outer side of the artery and somewhat superficial to it lie the roots of the brachial plexus The vein is therefore pushed down with a blunt spatula whilst the brachial plexus is pulled up with a blunt hook The sheath of the artery is now opened and the needle insinuated round the vessel from below upwards

2 Ligature of third part – The patient is placed upon the back close to the edge of the table and has the shoulders raised The arm is abducted to a right angle and is externally rotated

An incision is made about 3 inches in length along the line of the artery (Fig 16) After the integuments and fascia have been divided, the inner margin of the coraco brachialis should be exposed The position of the artery can now be seen and the needle is passed from within outwards to ligature the artery

CHAPTER III

LIGATURE OF THE ARTERIES OF THE HEAD AND NECK

Subclavian Artery

A ligature has been applied to each of the three parts of the subclavian artery So far as surgical experience at present extends it may be said that the operation is rarely justifiable except in the third part of the artery

Ligature of the third part of the artery *Position*—The patient lies upon the back close to the edge of the table with the thorax raised and the head extended and turned to the opposite side

The arm should be pulled well down and fixed This latter object may be effected by passing the arm behind the back whenever that is possible and allowing it to remain fixed in that posture Or an assistant may hold the arm steadily drawn down from the trunk The operator stands in front of the shoulder A good light is necessary

Operation—The skin over the posterior triangle having been drawn down with the fingers of the left hand an incision is made through it down to the clavicle By adopting this plan risk of wounding the external jugular vein is avoided The incision which is transverse should be about 3 inches in length and when the traction upon the skin is withdrawn should lie about half an inch above the clavicle (Fig 17) It should extend across the base of the posterior triangle from the trapezius to the sterno mastoid and should be so planned that the centre of the wound shall correspond to a point about an inch to the inner side of the centre of the clavicle This first incision divides the integuments the platysma and

the supraclavicular nerves, with possibly a vein which passes over the clavicle to connect the cephalic vein with the external jugular The amount of trapezius and sterno mastoid exposed will depend upon the extent to which those muscles are attached to the clavicle

The deep cervical fascia is now reached and is divided in the length of the original wound No director should be

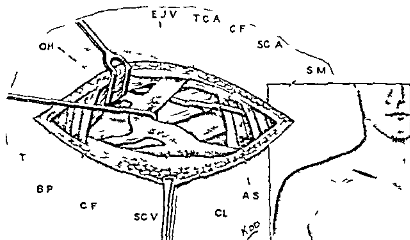


Fig 17 —Ligature of the right subclavian (third part)

OH Omo hyoid muscle E J V ext jugular vein T C A transverse cervical artery C F cervical fascia SC A subclavian artery S M sterno mastoid muscle A S anterior scalene muscle CL clavicle SC V sub clavian vein B P brachial plexus T trapezius muscle

employed The external jugular vein must now be dealt with Very probably it can be drawn aside, and may be held by a small blunt hook towards the outer angle of the wound If it obstruct the area of the operation in a more determined manner it may have to be divided between two ligatures Sometimes when an actual plexus of veins exists in front of the artery, much difficulty is encountered All

bleeding vessels must be secured The wound throughout should be as bloodless as possible

The outer margin of the anterior scalene muscle should next be defined and the position of the omo hyoid made out (Fig 17) The latter muscle if at all in the way must be drawn upwards When the edge of the scalene muscle has been made plainly evident the finger should be passed along it until the tubercle on the first rib is encountered Note that this tubercle is placed on the *inner* border of the rib which latter is usually grooved by the artery crossing the bone immediately behind the scalene muscle The finger will now be in contact with the artery and its pulsations can be felt in the living subject In the dead the artery will be felt to flatten out on the rib being the first structure behind the tubercle A little careful dissection will clear the artery and bring into view the lowest cord of the brachial plexus

This nerve cord should be systematically exposed by a slight and careful dissection Note that it has been the source of some of the more serious mistakes which have been made in this operation The subclavian vein may be seen and felt but it seldom encroaches much upon the field of the operation

The transverse cervical artery runs high up and will probably not come into view The suprascapular artery keeps under cover of the clavicle The fascia surrounding the subclavian is fairly substantial

The needle (unthreaded) may now be very carefully passed from above downwards Its course must be directed by the forefinger of the left hand By this finger the vein is protected and held out of the way If the needle be passed from below—i e from the vein—it is easy to pick up the last cord of the plexus with the artery The pleura has been wounded by a needle which has been carelessly passed This accident cannot occur if the needle be passed between the artery and the upper surface of the first rib

The operation is difficult and requires a steady hand and perfect control over the scalpel and forceps The parts should

be cautiously exposed by means of the knife and the blunt dissector, and not by tearing and rending with the fingers and blunt instruments

In order to obtain sufficient room, portions of the trapezius or of the sterno mastoid may have to be cut

The transverse cervical or suprascapular arteries may be in the way They should be drawn aside but in no case divided as they play a most important part in the collateral circulation These arteries have been injured during the operation as have also been the external jugular vein and the phrenic nerve

If the neck be short and the patient stout the difficulties of the operation are much increased Great difficulty will also be experienced when the veins have a plexiform arrangement or are engorged and when the tissues are found to be *œdematous and matted together*

In actual operations the following structures have been tied instead of the artery 1 (most often) the lowest cord of the brachial plexus 2 the suprascapular artery, 3, the omo hyoid muscle

In very few instances does the subclavian vein appear to have been wounded

Comment—It is remarkable how often ligature of the subclavian on the dead subject is either a failure or 'comes halting off' Sir William Macewen taught that this is generally due to the student working too far outwards, and he points out that a vertical line dropped from the angle of the lower jaw (the head facing forwards) will indicate the right spot More important than this are the proper position of the subject s shoulder (well depressed) and the careful identification of each successive landmark given above, especially the anterior scalene muscle and its tubercle on the first rib

Common Carotid Artery

Line of the artery—The course of the common carotid is represented by a line drawn from the sterno-clavicular articulation to a point midway between the angle of the jaw and the tip of the mastoid process.

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Common Carotid Artery

Line of the artery—The course of the common carotid is represented by a line drawn from the sterno-clavicular articulation to a point midway between the angle of the jaw and the tip of the mastoid process.

A valuable guide to the artery at about the point of crossing of the omo hyoid muscle is afforded by what is termed Chassaignac's carotid tubercle This is the costal process of the sixth cervical vertebra and the artery lies directly over it It is to be found about 2½ inches above the clavicle It is at the same level as the lower border of the cricoid cartilage

The common carotid may be secured at any part of its course in the neck The operations resolve themselves however into ligature above the omo hyoid muscle and ligature below it The former situation is in every respect to be preferred Below the muscle the vessel is deeply placed and has more complicated relations to structures of importance Farabeuf has well said that below the omo hyoid muscle the deaths are more numerous than the recoveries above the recoveries preponderate over the deaths

Position — The patient lies upon the back close to the edge of the table with the shoulders raised The chin should be drawn up and the head turned a little to the opposite side The surgeon stands upon the side exposed for operation

1 Ligature at the place of election (above the omo hyoid muscle) —The position of the cricoid cartilage having been defined and the situation of the superficial veins made evident an incision about 3 inches in length is made in the line of the artery and is so placed that its centre is on a level with the cricoid cartilage (Fig 18)

The skin and platysma having been incised (together with branches of the superficial cervical nerve) the surgeon divides the deep fascia along the anterior border of the sterno mastoid muscle Along this border a communicating vein between the facial and the anterior jugular may be met The edge of the muscle is defined and is followed until the omo hyoid muscle is made out The superior border of this structure must then be well exposed and the angle at which the two muscles meet must be clearly demonstrated The sterno mastoid may be drawn a little outwards and the omo hyoid downwards (Fig 18)

The pulsations of the artery should now be sought and the vessel can usually be easily detected as it crosses the conspicuous 'carotid tubercle' The artery is very mobile

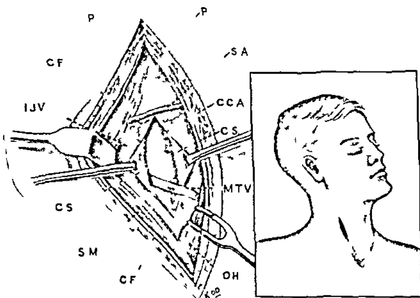


Fig 18 —Ligature of the right common carotid above the omo hyoid

P Platysma S A sterno mastoid artery C C A common carotid artery C S carotid sheath M T V mid thyroid vein O H omo hyoid muscle C F, cervical fascia I J V internal jugular vein

and slips readily to and fro under the finger If the pulse be feeble it may present the physical characters of a flat cord In exposing the sheath of the artery care must be taken to avoid the sterno mastoid vessel and the superior or middle thyroid veins double ligature of either may be necessary

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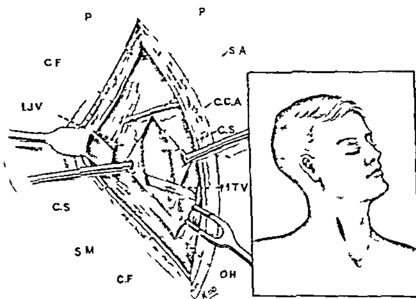


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The sheath should be opened upon the inner or medial side so as to avoid the internal jugular vein and precaution must be taken not to damage the descendens nerve Holding the sheath by the inner lip of the wound which has been made in it the surgeon with the blunt dissector should clear the artery upon its inner side The outer lip of the sheath being held in the forceps the outer side of the vessel is cleared in turn By shifting the forceps as required the whole circumference of the artery can be separated from its sheath This process must be carried out with great care and with thoroughness

The needle is passed from without inwards then threaded and withdrawn bringing with it the ligature

Comment—In uncomplicated cases the operation is a straightforward one If the tissues are matted together or are encroached upon by blood clot or are displaced by a tumour or growth the procedure may be attended with no little difficulty and risk

If the head be turned too much to the opposite side the sterno mastoid is carried unduly far over the artery, and the border of the muscle may be missed

The operation may be much complicated by the presence of large or distended veins The internal jugular vein is of considerable size is very thin and is readily wounded Its proportions are influenced by the respiratory movements and when the breathing is embarrassed it becomes at one time enormously swollen and at another moment flat and comparatively small

Two other veins though of less importance may give trouble in the operation One is the middle thyroid vein which joins the internal jugular passing outwards either over or under the artery The other is a communicating vein between the facial or external jugular and the anterior jugular low down in the neck It is inconstant but is sometimes of considerable size taking the place of the external jugular as it runs if present exactly in the line of the incision it is sometimes troublesome

The needle must be passed with great care The artery has

been transfixed by a needle which has been very roughly used The descendens the vagus and even the sympathetic cord have been accidentally included in the ligature For this reason we advise that the sheath should be gently detached all round by means of the blunt dissector before inserting the needle between it and the vessel

2 **Ligature below the omo hyoid muscle**—The position of the patient is the same as in the previous operation The incision is 3 inches in length is in the line of the artery and is so disposed as to commence a little below the level of the cricoid cartilage and end a little above the sterno clavicular joint It follows the inner border of the sterno mastoid muscle Care must be taken to avoid the communicating vein from the facial already described and also the anterior jugular vein (Fig 19)

External Carotid Artery

Line of the artery—The external carotid is represented by the upper part of the common carotid line

Operation—The position of the patient and of the operator should be the same as described in the previous operation

The 'place of election' is represented by the portion of the vessel between the superior thyroid and lingual arteries

An incision 2½ to 3 inches in length is made in the line of the artery from a point about on a level with the middle of the thyroid cartilage to near the angle of the jaw The greater cornu of the hyoid bone will be about the centre of the incision (Fig 20)

The integuments and platysma having been divided and any superficial vein secured the fascia is cut through and the anterior border of the sterno mastoid exposed in the lower part of the wound This muscle must be drawn outwards The posterior belly of the digastric should next be sought for at the upper angle of the wound and below it the hypoglossal nerve should be made evident The surgeon then seeks with the finger for the tip of the great cornu of the hyoid bone and when this is discovered all the 'points' leading to the artery are in evidence (Fig 20)

The artery should not be exposed opposite to the level of the tip of the great cornu and between the origins of the superior thyroid and lingual arteries In this part of the operation care must be taken to avoid the facial and superior thyroid veins Lymphatic glands lie close to the vessel and

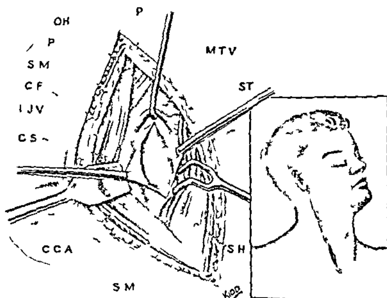


Fig 19 —Ligature of common carotid below omo hyoid

P Platysma M T V middle thyroid vein ST sterno thyroid muscle S H sterno hyoid muscle S M sterno mastoid muscle C C A common carotid artery C S carotid sheath I J V internal jugular vein OH omo hyoid muscle

may easily obscure it in that case they should be excised The artery having been cleared the needle is passed from without inwards In effecting this great care must be taken to avoid the superior laryngeal nerve which courses behind the artery in this situation The internal carotid runs up parallel to the external one but rather deeper and to its outer side It is important not to tie the internal in mistake

note that it is the larger of the two vessels and that it gives off no branches

Comment —This operation is somewhat difficult, partly on account of the complicated relations of the artery, and partly from the fact that the branches are not always readily

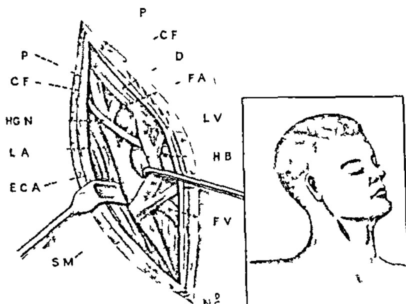


Fig 20 —Ligature of the right external carotid

P Platysma C F cervical fascia D digastric muscle F A facial artery L V lingual vein H B great cornu of hyoid bone F V facial and superior thyroid veins S M sterno mastoid muscle E C A external carotid artery L A lingual artery H G N hypoglossal nerve

identified In spite of its comparative difficulty the external should always be selected for ligature in preference to the common carotid where the choice exists e g preliminary to extensive operation on the upper jaw tongue etc Tying the common carotid involves considerable risk to the brain, especially in adult or elderly subjects Ligature of the external involves no such risk

The artery should not be exposed opposite to the level of the tip of the great cornu and between the origins of the superior thyroid and lingual arteries In this part of the operation care must be taken to avoid the facial and superior thyroid veins Lymphatic glands lie close to the vessel and

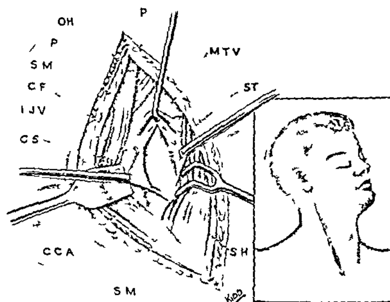


Fig 19.—Ligature of common carotid below omo hyoid

P Platysma M T V mid thyroid veins ST sterno thyroid muscle S H sterno hyoid muscle S M sterno mastoid muscle C C A common carotid artery C S carotid sheath I J V internal jugular vein OH omo hyoid muscle

may easily obscure it in that case they should be excised The artery having been cleared the needle is passed from without inward In effecting this great care must be taken to avoid the superior laryngeal nerve which courses behind the artery in this situation The internal carotid runs up parallel to the external one but rather deeper and to its outer side It is important not to tie the internal in mistake

note that it is the larger of the two vessels and that it gives off no branches

Comment —This operation is somewhat difficult, partly on account of the complicated relations of the artery, and partly from the fact that the branches are not always readily

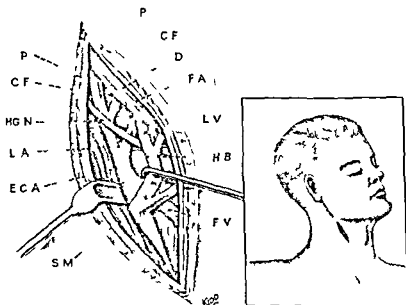


Fig 20 —Ligature of the right external carotid

P Platysma CF cervical fascia D digastric muscle FA facial artery LV lingual vein HB great cornu of hyoid bone FV facial and superior thyroid veins SM sterno mastoid muscle ECA external carotid artery LA lingual artery HGN hypoglossal nerve

identified In spite of its comparative difficulty the external should always be selected for ligature in preference to the common carotid where the choice exists e g preliminary to extensive operation on the upper jaw, tongue, etc Tying the common carotid involves considerable risk to the brain especially in adult or elderly subjects Ligature of the external involves no such risk

The arterv has been ligatured above the digastric, but this procedure is still more difficult and is attended with several special risks

INTEPNAL CAROTID APTEPY

The sole indication for ligature of this arterv is aneurysm of the vessel itself in any part of its course Such an aneurysm mav be in its intracranial portion e g in the cavernous sinus The incision and other steps are practically identical with those relating to the external carotid The incision should reach down at least as low as the bifurcation (generally the upper border of the thyroid cartilage) and in the deep dissection it is well to expose the bifurcation clearly The internal carotid differs from the external in the points mentioned above it is also more overlapped by the internal jugular which must be carefully retracted The ligature should be placed some little distance above the bifurcation if the aneurysm does not allow of this being done it is better to tie the common carotid and the external also (to prevent collateral circulation interfering with the clot)

Comment - In young subjects there is comparatively slight risk to the brain from shutting off either the internal carotid or its parent stem the common one But the risk increases enormously after the age of 40 (Victor Horsley)

Of all cases of ligature of the common carotid, 20-25 per cent develop cerebral softening in some degree the symptoms may only come on a week or two after the operation Of this 20-25 per cent certainly half the cases die as a result of the operation and the remainder are left partially paralysed

LINGUAL APTERY

The arterv may be secured in either the first or the second part of its cours In the former situation a ligature is but rarely applied the place of election being in the second segment of the vessel a it lies beneath the hyo glossus muscle and occupies the di tric triangl This artery is rarely ligatured in practice ince ligature of the external carotid is

easier and as effective The following section may be read conveniently with that of the submaxillary salivary gland (page 313)

Ligature of the artery at the "place of election" *Position*—The patient lies close to the edge of the table with the shoulders raised and with the face turned to the opposite side An assistant must keep the chin drawn well upwards and the lower jaw fixed The surgeon stands on the side to be operated upon The chief assistant is placed opposite to him and leans over the patient s body A second assistant stands by the surgeon s side His chief duty is to hold the hook which commands the digastric tendon The patient must be well anæsthetized before the operation is commenced

Operation—An incision about 3 inches in length and with the convexity downwards is made between the lower jaw and the hyoid bone The incision commences a little below and to the outer side of the symphysis and ends near the angle of the jaw (Fig 21) On the right side the incision is made from behind forwards on the left side from before backwards

The integument platysma and superficial fascia are divided in the line of the incision Certain superficial veins will be encountered and some will probably have to be secured These veins are the submental or other tributary of the facial or some tributary of the anterior jugular

It will now be convenient to apply ligature retractors in order that the depths of the wound may be well laid open

The next step is fully to expose the submaxillary gland It is lodged in a special compartment of the cervical fascia This fascia should be opened transversely over the lower part of the gland which should be cleared and brought well out into the wound by means of the finger and the handle of a scalpel The gland should be turned upwards on to the margin of the jaw and be kept out of the operation area by means of a broad and well-curved retractor held by the chief assistant

The fascia exposed by the lifting out of the salivary gland

is now to be divided transversely, and in the anterior angle of the wound the posterior edge of the mylo hyoid muscle must be sought for and defined

The digastric tendon and the two bellies of the muscle are now to be brought clearly into view Around the tendon where it is nearest to the hyoid bone a blunt hook is to be passed and held by the assistant who stands at the surgeon s side The tendon should be drawn downwards and towards the surface

By this means the area of the operation is brought well into view and is increased in extent the parts are fixed the hyoid bone carrying with it the hyo glossus muscle is brought nearer to the surface and the muscle in question is put on the stretch

The hyo glossus muscle can now be easily made out and its exposed surface freed of connective tissue The hypoglossal nerve must be sought for as it crosses the muscle and the surgeon s work be limited to the segment of muscle below the nerve (Fig 21) in the triangle formed by the hypoglossal above the digastric behind and the mylo hyoid in front

Crossing the hyo glossus below the nerve and parallel with it is the ranine vein This vein will about correspond in position with the artery which lies beneath the muscle

The vein and the nerve should be displaced upwards

The hyo glossus muscle is divided transversely for a short distance a little above the margin of the hyoid bone and parallel with it

The incision in the muscular tissue must be cautiously deepened If the cut has been well placed the artery will bend out into the wound and make itself evident as soon as the whole thickness of the muscle has been divided

The needle is most conveniently passed from above downwards In the ligature the minute venæ comites which attend the artery are no doubt included

Comment —This operation requires a good light and is only performed with ease and certainty when the procedure is carried out step by step

The stages of the operation should be marked in succession by the *following points* 1 The *complete* lifting up of the submaxillary gland 2 The demonstration of the posterior edge of the mylo hyoid muscle 3 The clearing of the digastric tendon and the drawing of it downwards

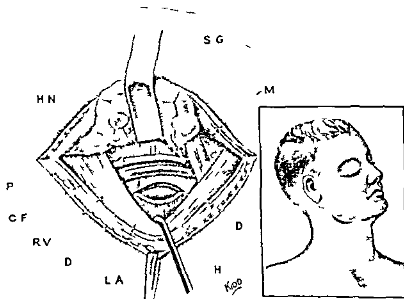


Fig 21 —Ligature of the right lingual

S G submaxillary gland M mylohyoid muscle D digastric tendon H hyoglossus muscle L A lingual artery R V ranine vein C F cervical fascia P platysma H N hypoglossal nerve

with a hook 4 The demonstration of the hypoglossal nerve on the hyo glossus muscle

The incision may be of less dimensions than those given or may be extended if required

If the cut be carried too far back the facial vein and artery are endangered Time should not be wasted over the early part of the operation Such veins as are cut may be clamped

and left, to be ligatured later The gland must be well exposed The chief difficulties of the operation depend upon the gland This gland varies in size in density and in the closeness of its attachments These variations are probably never normal but are incident to changes connected with cancer of the tongue

As the wound becomes deep and the area of the operation very narrow a pair of long bladed and fine dissecting forceps is needed

The fixing of the digastric tendon and the hyoid bone by means of the small hook is an essential part of the operation Embarrassed breathing may form a serious complication in the later stages of the procedure

The lingual has been cut in dividing the muscle carelessly The bulging of the artery into the wound in the muscle is very characteristic

Pulsation in the vessel may not be obvious If the artery is not found on dividing the hyo glossus the operator should not make the mistake of going too deep but should look under the edge of the divided muscle The stylo hyoid ligament has even been mistaken for the artery The direction of the latter upwards and forwards should be borne in mind

When operating for cancer of the tongue the submaxillary gland with all adjacent lymphatic glands is usually removed as a preliminary step Ligature of the lingual artery is then a very easy procedure Many surgeons however in excising the tongue do not ligature the lingual in the neck but secure the ranine branch (A profunda linguæ) in the mouth after division of the mucous membrane at the side of the tongue The neck operation however gives the best control over hæmorrhage and enables the lymphatic glands to be cleared away at the same time

Ligature of the Innominate Artery

Cases of aneurysm of the innominate artery are best treated by ligature This ligature is usually applied distally but in rare circumstances proximal ligation is possible

Proximal ligation is desirable as otherwise the high pressure and tremendous pressure changes in the aorta tend to increase the size of the sac, in spite of distal ligation The aneurysm

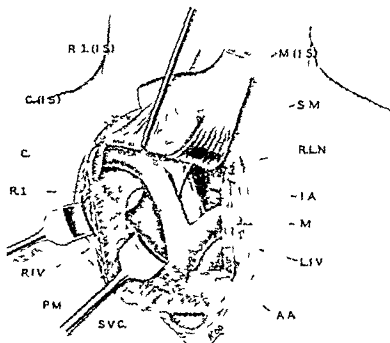


Fig 22 —Approach to innominate artery

R 1 (I.S) First rib internal surface of turned up portion C (I.S) clavicle internal surface of turned up portion C clavicle R 1 first rib R I V right innominate vein P M pectoralis major (turned down) S V C superior vena cava M (I.S) manubrium internal surface turned up portion S M sternothyroid muscle R L N recurrent laryngeal nerve I A innominate artery M manubrium L I V left innominate vein A A arch of aorta

at the bifurcation of the innominate artery is the ideal type for proximal ligature (Ballance) In such cases the common carotid artery must also be tied to prevent distal embolism Triple ligation of the innominate common carotid and subclavian is the ideal treatment

Access is of course all important The best approach is that described by Wheeler (Fig 22) The inner end of the clavicle is divided lateral to the origin of the sterno mastoid muscle The right half of the manubrium sterni is sawn across and the manubrium then split vertically This

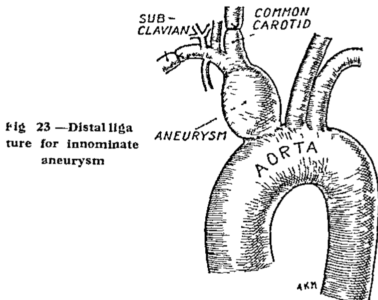


Fig 23 —Distal ligature for innominate aneurysm

complete flap which includes the sterno clavicular joint is then reflected upwards This gives excellent access to the vessel All smaller vessels which interfere with vision may be divided between ligatures The left innominate vein is displaced downwards

This operation is of course much easier in the dissecting room as in these cases there is no large adherent aneurysmal sac

In those cases where proximal ligature is impossible distal ligature should be performed (Fig 23)

CHAPTER IV

LIGATURE OF THE ARTERIES OF THE LOWER LIMB

Anterior Tibial Artery

Line of the artery.—From a point midway between the head of the fibula and the outer tuberosity of the tibia to the centre of the front of the ankle joint

Position—The patient lies upon the back. The limb is straight upon the table. The foot projects beyond the edge of the table and is forcibly extended and (with the leg) fully rotated inwards. The surgeon stands always to the outer side of the limb. The incision for the right artery is made from above down, for the left from below up. Two assistants stand on the opposite side of the table—one steadies the leg and manipulates the foot, the other attends to the wound

Ligature in the upper third of the leg.—Before anæsthetizing the patient the outer margin of the tibialis anterior should be, if possible, defined by causing the patient to contract the muscle.

An incision 3½ inches in length is made precisely along the line of the artery (Fig 24). Its upper end will be about an inch below the head of the tibia. The deep fascia is exposed and is divided along the same line. The interval between the tibialis anterior and extensor communis digitorum is made out. The foot is now flexed to relax these muscles. The space between them is opened up by means of the finger and the handle of

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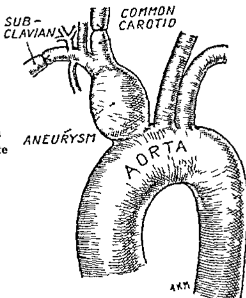


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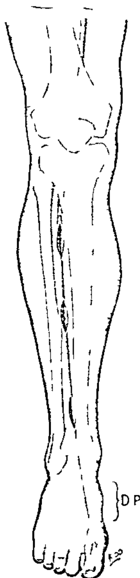
ANTERIOR TIBIAL ARTERY

Line of the artery—From a point midway between the head of the fibula and the outer tuberosity of the tibia, to the centre of the front of the ankle joint

Position—The patient lies upon the back The limb is straight upon the table The foot projects beyond the edge of the table and is forcibly extended and (with the leg) fully rotated inwards The surgeon stands always to the outer side of the limb The incision for the right artery is made from above down for the left from below up Two assistants stand on the opposite side of the table—one steadies the leg and manipulates the foot the other attends to the wound

1 Ligature in the upper third of the leg—Before anæsthetizing the patient the outer margin of the tibialis anterior should be if possible defined by causing the patient to contract the muscle

An incision 3½ inches in length is made precisely along the line of the artery (Fig 24) Its upper end will be about an inch below the head of the tibia The deep fascia is exposed and is divided along the same line The interval between the tibialis anterior and extensor communis digitorum is made out The foot is now flexed to relax these muscles The space between them is opened up by means of the finger and the handle of



the scalpel In doing this the external border of the tibia is aimed for and should be distinctly felt before the artery is sought In proceeding towards this border the extensor communis is held down by the first two fingers of the left hand while the assistant holds the tibialis anterior toward the tibia with a retractor The outer border of the tibia having been made out with the forefinger the artery will be found to the outer side of it lying on the interosseous membrane It is covered and held down by a moderately dense connective tissue The artery is now exposed a second retractor being used to repress the extensor communis (Fig 25)

The venæ comites lie so close to the artery and in such a position and send so many transverse branches across it that it is practically impossible to separate them with certainty They will be probably enclosed in the liga ture The nerve lies to the outer side of the artery The needle is passed from without inwards

Comment —The only difficulty in this operation is the finding of the gap between the tibialis anterior and the extensor communis digitorum Not the least indication of it exists upon the surface of the deep fascia The white line described by some authors is a

Fig 24 –Ligature of the anterior tibial and of the dorsalis pedis

D P Dorsalis pedis

myth so far at least as this segment of the limb is concerned The gap required is to be felt rather than seen

2 **Ligature in the middle third of the leg** – Make an incision 3 inches in length along the line of the artery (Fig 24) The deep fascia is exposed The interval between the tibialis anterior and extensor communis is indicated by a yellowish white line This is due not to a distinct septum, but to a line of fatty tissue lodged between the two muscles In emaciated subjects the line may not be apparent The deep fascia is divided along this line The

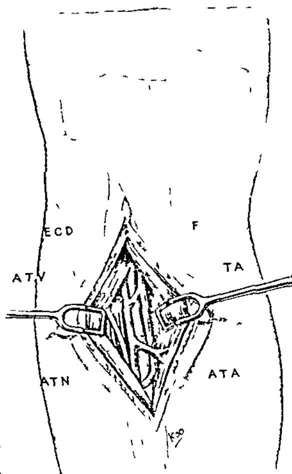


Fig 25 —Ligature of the right anterior tibial (upper third)

F Fascia T A tibialis anterior muscle A T A anterior tibial artery A T N anterior tibial nerve A T V anterior tibial veins E C D extensor communis digitorum

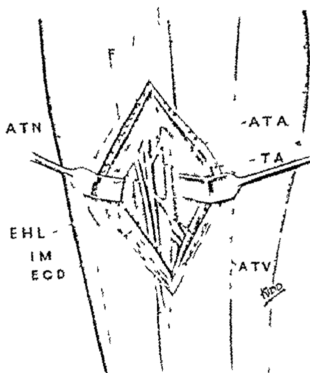


Fig 26 —Ligature of the anterior tibial artery (mid third)

F [illegible] ATA [illegible] tibial artery TA [illegible] anteri[illegible] ATV [illegible] ECD [illegible] communis [illegible] interosseous membrane EHL ext[illegible] ATN anterior tibial ne[illegible]

two muscles above named are found lying close together The outer edge of the tibialis anticus is still muscular but the inner edge of the common extensor is now tendinous

Flex the foot Separate the muscles with the handle of the scalpel keeping in the direction of the tibia The artery is found upon the interosseous membrane with the still deeply placed extensor hallucis longus to its outer side The nerve will be exposed before the artery is reached since it here usually lies in front of the vessel The needle may be passed from either side It may be impossible to separate the venæ comites but great care must be taken to avoid the nerve In the living subject persistent attempts to separate the venæ comites will probably only lead to laceration of those vessels It is better to tie veins and artery together

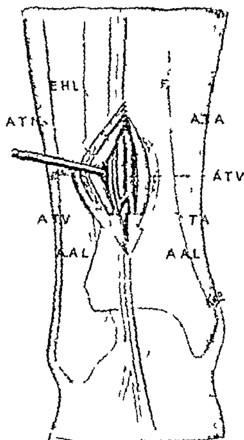


Fig 27 —Ligature of right anterior tibial (lower third)

F Fascia ATA anterior tibial artery ATV anterior tibial veins TA tibialis anterior AAL anterior annular ligament EHL extensor hallucis longus ATN anterior tibial nerve

3 **Ligature in the lower third of the leg** —The position is the same only the foot need not be rotated inwards so much

An incision 2 to 2½ inches in length is made in the line of

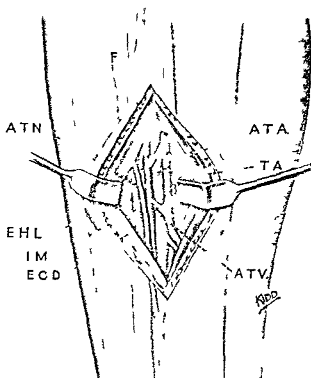


Fig 26 —Ligature of the anterior tibial artery (mid third)

F Fascia A T A anterior tibial artery T A tibialis anterior A T V anterior tibial veins E C D extensor communis digitorum I M interosseous membrane E H L extensor hallucis longus A T N anterior tibial nerve

two muscles above named are found lying close together The outer edge of the tibialis anticus is still muscular but the inner edge of the common extensor is now tendinous

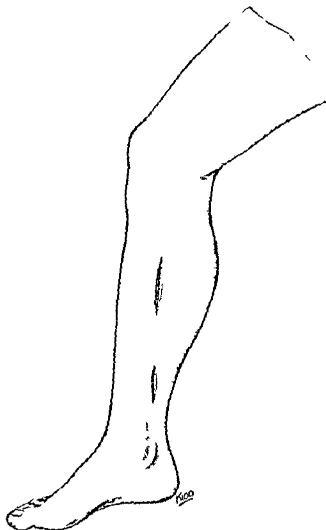


Fig 28 —Ligature of the right posterior tibial

2 **Ligature in the middle of the calf** —The calf of the leg rests upon the table on its outer side and the surgeon leans over the limb The incision is made from

the artery, and a little to the outer side of the tendon of the tibialis anterior

The tendon must be identified beyond doubt before the operation is proceeded with The deep fascia—here known as the upper band of the anterior annular ligament—is divided in the same line and the space between the tibialis anterior tendon and the tendon of the extensor hallucis longus is defined Both these tendons will be exposed The artery lies between them on the front of the tibia and embedded in a considerable quantity of fatty connective tissue The foot is a little flexed the extensor hallucis longus tendon is drawn to the outer side by a small blunt hook and the exposed artery is easily secured

The nerve lies to the outer side and the needle should be passed from the nerve As the vessel is quite superficial the venæ comites may be separated so as to make room for the needle (Fig 27)

POSTERIOR TIBIAL ARTERY

Line of the artery —A line drawn from the centre of the ham to a point midway between the inner malleolus and the heel will correspond to about the lower half of the artery The upper half forms a slight curve inwards from this line

Position.—The patient lies on the back The knee is flexed and the leg lies upon its outer side The foot lies upon the table also on its outer side and is secured in that posture by an assistant The surgeon stands to the outer side of the limb in either instance (right or left limb)

1 **Ligature in the lower third of the leg** —An incision 2 inches in length is made along the line of the artery midway between the margin of the tendo Achillis and the inner edge of the tibia (Fig 28) The superficial and deep fasciæ are divided together with the upper part of the inner annular ligament The artery is found lying on the flexor digitorum longus muscle with the nerve to its outer side The needle is passed from the nerve The venæ comites will have to be included if they cannot be readily separated from the artery (Fig 29)

internal saphenous vein, which should be drawn aside The deep fascia—the fibres of which are all transverse—is exposed and divided The inner margin of the gastrocnemius is probably seen and retracted backwards

The soleus is now exposed and must be divided through the length of the incision The aponeurosis of the muscle is cut through together with the fleshy fibres attached to it In making this section the knife should be kept perpendicular to the surface of the muscle Its edge will therefore be directed towards the tibia and its blade—in the position in which the limb is held—will be nearly horizontal When the muscle has been divided the outer part must be drawn well outwards by a broad retractor or retractors held by an assistant The deep fascia that covers in the vessels and the deep muscles of the leg are now exposed If the finger be introduced the vessel can be felt It must be remembered that the artery lies near the outer border of the tibia When the fascia has been divided (it is usually very thin) the fleshy fibres of the flexor longus digitorum are exposed These fibres all run obliquely downwards By following the surface of the muscle the vessels are reached The veins are very conspicuous and may hide the artery The nerve lies to the outer side and the needle should be passed from the nerve It is practically impossible to separate the venæ comites from the vessel

Comment—This operation requires a good light and may be most conveniently done with the aid of an electric head lamp

The tissues must be carefully retracted and all the soft parts drawn outwards In using the retractors roughly some fibres of the flexor longus digitorum may be torn up and made to hide the artery This may readily occur in the cadaver If in dividing the soleus the knife be not kept towards the tibia a too extensive division of muscle results and the wound is unnecessarily deepened

In identifying muscle it should be remembered that the fibres of the soleus in this situation are attached only along the narrow line formed by the inner margin of the tibia The

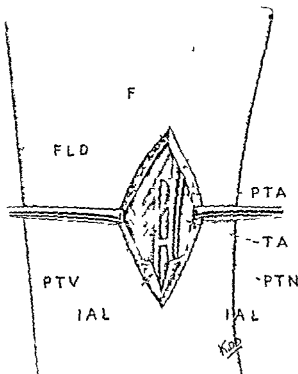


Fig 29 —Ligature of the right posterior tibial (lower third)

F Fascia PTA posterior tibial artery PTN posterior tibial nerve IAL internal annular ligament PTV posterior tibial veins FLD flexor longus digitorum and tendon TA tendo Achillis

above downwards on the right side and from below upwards on the left The assistant armed with retractors stands on the opposite side of the table

An incision 4 inches in length is made in the middle third of the leg parallel to the inner margin of the tibia and a finger's breadth behind that crest of bone (Fig 28) The skin having been divided care must be taken not to wound the

and one side of the chest and is indeed made to lie as nearly prone as the circumstances attending the administration of an anæsthetic will permit The limb is fully extended The *surgeon stands to the outer side of the left limb and to the inner side of the right The chief assistant is placed* opposite to him In either extremity the incision is made from above downwards

A vertical incision from 3 to 3½ inches in length is made over the back of the limb commencing opposite to the centre of the popliteal space (i e the level of the knee joint) and extending downwards over the interval between the two heads of the gastrocnemius muscle In seeking an embolus a much more generous incision should be used

The skin and superficial fascia having been divided care must be taken not to damage the short saphenous vein and nerve These structures will appear at the outer part of he wound, and should be drawn outwards The deep fascia is divided in the same vertical line

The heads of the gastrocnemius muscle are now exposed and the surgeon follows the interval between them On each side of this gap a sural artery will be found accompanied by the nerve to the corresponding head of the muscle

Deep in the interval itself the large nerve to the soleus muscle (from the medial popliteal) will probably be met with *and must be drawn aside It usually lies directly in the line* of the operation

Following the short saphenous vein the surgeon is guided to the popliteal vessels This part of the operation is rendered easier by flexing the knee joint a little so as to relax the gastrocnemius The medial popliteal nerve is first encountered then the vein and the artery The two *first named structures* are drawn to the inner side The artery is cleared and the needle is passed from the inner side (Fig 30)

2 **Ligature of the upper part of the artery** —This operation is carried out in the thigh The vessel is secured close to the inner side of the femur and is reached between the semimembranosus muscle and the tendon of the adductor magnus

The patient lies upon the back with the hip a little flexed

surgeon should not lose sight of the fact that the part for which he is aiming is in a line with the outer margin of the tibia

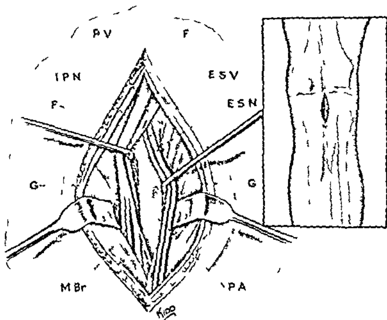


Fig 30 — Ligature of the right popliteal (lower part)

F Fascia P V popliteal vein E S V external saphenous vein E S N external saphenous nerve G gastrocnemius muscle M Br muscular branches of I P N I P N internal popliteal nerve P A popliteal artery

Popliteal Artery

This artery is important from the point of view of embolectomy the guide to the upper part of the artery is the outer border of the semimembranosus The popliteal ends on a level with the lower part of the tubercle of the tibia

1 **Ligature of the lower part of the artery** — The patient is so rolled over as to rest upon the shoulder

An aneurysm needle with a large lateral curve will be found the most convenient In performing this operation, care must be taken not to wound the deep branch of the anastomotica magna artery which runs along the anterior surface of the adductor magnus tendon

Femoral Artery

Line of the artery —The hip being a little flexed and the thigh abducted and rotated outwards a line is drawn from a point midway between the anterior superior spine of the ilium and the symphysis pubis to the adductor tubercle on the internal condyle The centre of Poupart s ligament is entirely to the outer side of the line of the vessels

The superficial femoral may be ligatured in Hunter's canal or at the apex of Scarpa s triangle The common femoral may be ligatured at the base of that triangle

Position —The patient lies upon the back with the hip a little flexed the thigh abducted and rotated outwards, the knee bent and the leg resting upon its external surface

The surgeon stands to the outer side of the limb in either case and the chief assistant is placed opposite to him The incision in the right thigh, is made from above downwards, and in the left from below upwards

1 Ligature of the superficial femoral in Hunter's canal —The limb having been placed as already indicated, an incision about 3 inches in length is made along the line of the artery in the middle third of the thigh (Fig 31)

In the layer of subcutaneous tissue the anterior division of the internal cutaneous nerve will probably be met with and to the inner side of it the long saphenous vein This vessel must be drawn inwards

The fascia lata is now divided in the line of the original wound and the sartorius is exposed This muscle must be clearly identified Its fibres run downwards and inwards

The anterior or outer edge of the muscle having been exposed the whole structure is drawn inwards with a suitable retractor

and the thigh fully abducted and rotated outwards The knee joint is bent at a right angle and the knee and leg are thus made to lie upon the outer side

The surgeon stands to the outer side of the extremity in either case The incision on the right side is made from above downwards and on the left from below upwards The chief assistant faces the operator

The incision is 3 inches in length is commenced at the junction of the middle and the lower thirds of the thigh (Fig 31) and is parallel with and just posterior to the tendon of the adductor magnus The position of this tendon should have been well defined

After the skin has been divided there will probably be found in the subcutaneous fat the anterior division of the internal cutaneous nerve which lies usually in the direct line of the operation It should be drawn aside

The anterior edge of the sartorius muscle is next exposed and the whole muscle must be displaced backwards

Upon the sartorius at this point will lie the internal saphenous vein The vessel may possibly be exposed in which case it is drawn backwards with the muscle

The trunk of the internal saphenous nerve is not encountered It lies beneath the sartorius

The deep fascia having been well divided the tendon of the adductor magnus is sought for and is drawn forwards with a blunt hook The semimembranosus muscle is next exposed and is drawn backwards with a retractor The operator now seeks for the artery in the interval between the two structures The vessel will be surrounded by much connective tissue and is lying close to the bone The internal popliteal nerve is here at some distance from the vessel and will not be seen

The vein also is not necessarily exposed It lies posteriorly to the artery, and to its outer side Indeed as approached from this point the artery is the most superficial of the three structures named When the vessel has been properly exposed the needle may be passed from below upwards

An aneurysm needle with a large lateral curve will be found the most convenient In performing this operation, care must be taken not to wound the deep branch of the anastomotica magna artery which runs along the anterior surface of the adductor magnus tendon

FEMORAL ARTERY

Line of the artery —The hip being a little flexed and the thigh abducted and rotated outwards a line is drawn from a point midway between the anterior superior spine of the ilium and the symphysis pubis to the adductor tubercle on the internal condyle The centre of Poupart s ligament is entirely to the outer side of the line of the vessels

The superficial femoral may be ligatured in Hunter s canal or at the apex of Scarpa s triangle The common femoral may be ligatured at the base of that triangle

Position —The patient lies upon the back with the hip a little flexed the thigh abducted and rotated outwards the knee bent and the leg resting upon its external surface

The surgeon stands to the outer side of the limb in either case and the chief assistant is placed opposite to him The incision in the right thigh is made from above downwards and in the left from below upwards

1 **Ligature of the superficial femoral in Hunter's canal** —The limb having been placed as already indicated, an incision about 3 inches in length is made along the line of the artery in the middle third of the thigh (Fig 31)

In the layer of subcutaneous tissue the anterior division of the internal cutaneous nerve will probably be met with and to the inner side of it the long saphenous vein This vessel must be drawn inwards

The fascia lata is now divided in the line of the original wound and the sartorius is exposed This muscle must be clearly identified Its fibres run downwards and inwards

The anterior or outer edge of the muscle having been exposed the whole structure is drawn inwards with a suitable retractor

The site of Hunter's canal lying between the adductor magnus and the vastus internus, can now be well defined especially if the fibres of the great adductor and the lower border of the adductor longus are made prominent by fully abducting the thigh

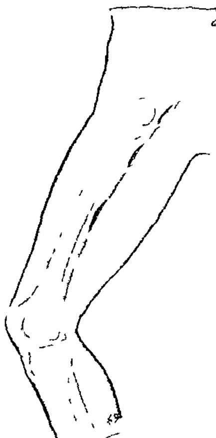


Fig 31.—Sites for the ligature of the femoral artery

When any fatty tissue which may obscure the part has been cleared away the fascia which forms the roof of Hunter's canal is rendered distinct The fibres forming this fascia are arranged transversely At this point there may be exposed, at the outer side of the wound the nerve to the vastus medialis The canal is opened in the line of the original wound and the artery exposed (Fig 32) and detached from its sheath with the use of the blunt dissector great care being taken not to injure the vein which lies close to the artery but out of sight We have frequently seen the vein injured on the dead body The needle may be passed from either side In front and to the outer side of the vessel will be found the internal saphenous nerve which is easily avoided

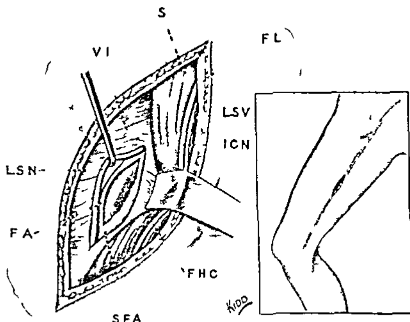


Fig 32 —Ligature of the right femoral in Hunter s canal

FL Fascia lata S sartorius muscle LSV long saphenous vein ICN internal cutaneous nerve antr Br FHC fascia closing in Hunter s canal SFA sheath of femoral artery FA femoral artery LSN long saphenous nerve VI vastus internus muscle

Care must be taken that the vein be not damaged in passing the needle round the artery

Comment —The cut is apt to be made too far outwards in which case the vastus medialis is exposed instead of the sartorius and the one muscle may be mistaken for the other. Their fibres however run in opposite directions those of the vastus downwards and outwards those of the sartorius downwards and inwards

The incision may be made too low down and the popliteal artery be reached In making the skin wound carelessly the internal saphenous vein has been cut into There is

of course no harm in dividing it between two ligatures if necessary

The whitish tendon of the adductor magnus has been mistaken for the artery in the dead subject

Farabeuf recommends that as soon as the sartorius muscle has been drawn aside the thigh should be well abducted and rotated out so as to bring into prominence a tendinous cord —*la corde qui vibre*—which is derived from the lower fibres of the adductor longus and is passing to the general adductor insertion This cord helps to define the canal and the incision is made first to its outer side

This is the classical Hunterian operation and answers admirably in most cases of popliteal aneurysm though now and then the collateral circulation may be too free to allow firm clotting

2 Ligature of the superficial femoral at the apex of Scarpa's triangle.—The limb is placed in the position already indicated and the line of the artery is marked out

An incision 3 inches in length is made along this line where it crosses the apex of Scarpa's triangle The centre of the wound should correspond to the apex and the incision therefore will reach to within 1½ or 2 inches of Poupart's ligament (Fig 31)

A large tributary of the internal saphenous vein will usually be exposed and if it cannot be drawn easily aside it should be divided between two ligatures

The fascia lata having been divided in the original line the sartorius is exposed at the outer part and inferior end of the wound its fibres running downwards and inwards

Its inner border should be well isolated and the whole muscle is then drawn outwards

The operator now feels for the groove of the artery In front of the vessel will be found branches of the internal cutaneous nerve and deeper and to its outer side are the long saphenous nerve and possibly the nerve to the vastus medialis (Fig 33)

The sheath of the vessel should be well opened and the needle passed from the inner side

Comment—Scarpa's triangle is much smaller than would appear to be the case when the dissected region is inspected There may be no more than 2 inches of the artery left un

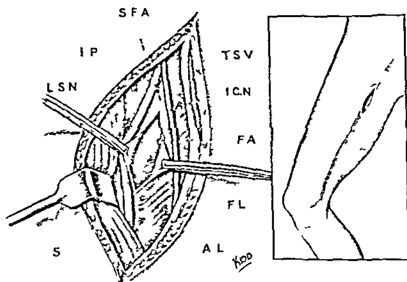


Fig 33 —Ligature of the right femoral at the apex of Scarpa's triangle

T S V Tributary of internal saphenous vein I C N internal cutaneous nerve F A femoral artery A L adductor longus F L fascia lata S sartorius muscle L S N long saphenous nerve I P ilio psoas muscle S F A sheath of femoral artery

covered by the sartorius muscle An unusually broad sartorius adds a little to the difficulty of the operation

In order to reach the edge of the sartorius muscle easily the cut is often made too much to the inner side with the result that the great saphenous vein is cut into On the other hand if the thigh be not placed in proper position the incision is apt to fall too much to the outer side

The special danger of the operation consists in wounding the vein in passing the needle The greatest care must be taken to open the sheath of the artery well and to keep the point of the needle close to the arterial wall

An aneurysm needle curved laterally will usually be found the more convenient It's point should be gently insinuated round the artery

The chief indication for ligature of the artery in Scarpa s triangle has been aneurysm in the popliteal space But there is more risk of failure to cure from the collateral circulation being too free than in the case of ligature in Hunter s canal where the vessel can be occluded very near to the aneurysm The fact that the artery is perhaps more difficult of access in Hunter s canal should not affect the decision

3 Ligature of the common femoral at the base of Scarpa s triangle —The position of the surgeon and of the patient has been already indicated An incision 2 inches in length is commenced a little above Poupart s ligament (i e on the abdomen) and is carried downwards parallel with the line of the artery (Fig 31)

In dividing the layer of fatty tissue which covers the fascia lata care must be taken not to injure any of the lymphatic glands of the region and to avoid the super ficial veins notably the superficial epigastric and superficial circumflex iliac The cribriform fascia is now divided in the original line and especial care must be taken not to wound the superficial arteries the two which usually come nearest to the incision being the superficial external pudendal and the superficial epigastric

The lumbo inguinal branch of the genito femoral nerve lies upon the sheath of the artery but upon the outer side of the vessel

The sheath being clearly exposed and carefully opened the needle is passed from the inner side (Fig 31)

Comment —By starting from the level of the centre of Poupart's ligament the incision is placed to the outer side of the line of the ve sels and the vein is thus more certainly

avoided When the vein is at all distended it is apt to overlap the artery

The artery is variable in length from half an inch to 3 inches one sometimes meets with no common femoral vessel below Poupart s ligament

It is sometimes tied with the companion vein as the first step of a racket amputation through the hip joint

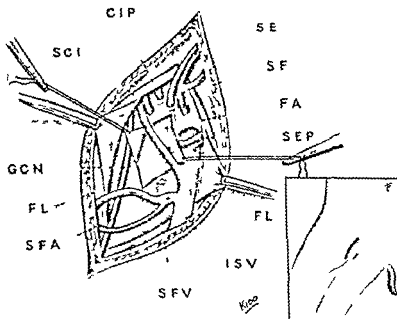


Fig 34 —Ligature of the right common femoral at the base of Scarpa s triangle

S I superficial epigastric artery and vein S F superficial fascia F A femoral artery S E P superior external pudic artery and vein F L fascia lata I S V internal saphenous vein S F V femoral vein (sheath of) S F A sheath of femoral artery G C N genitocrural nerve S C I superficial circumflex iliac artery and vein C I P circumflex iliac profunda artery

CHAPTER V

LIGATURES OF THE ILIAC ARTERIES—EXTERNAL, COMMON, AND INTERNAL

External Iliac Artery

Line of the artery.—A line drawn on the surface of the abdomen from a spot about a finger's breadth to the left of and below the navel to a point midway between the anterior superior iliac spine and the symphysis pubis The upper third of this line represents the common iliac the lower two thirds the external iliac

Methods of approaching the artery.—The iliac arteries including the external iliac can be approached in one of two ways 1 By opening the abdomen and directly exposing the vessel this is called the intraperitoneal method 2 By means of a lateral incision which divides all the structures of the abdominal wall with the exception of the peritoneum the peritoneum is pushed aside and the artery is reached without opening the serous cavity this is called the extraperitoneal method

Of these two methods the former or intraperitoneal plan is undoubtedly the better in dealing with the common or the internal iliac artery In ligaturing the external iliac vessel the two methods are of about equal value the balance if any being in favour of the extraperitoneal measure

1 Old or extraperitoneal method.—The patient lies upon the back with the thigh extended and close together The head and shoulders should be raised in order to relax the abdominal parietes a little

The surgeon stands to the outer side of the patient in dealing with either artery and cuts from above downwards on the right side and from below upwards on the left His

face is towards the patient's face The chief assistant is placed opposite to the surgeon and to him is entrusted the responsible office of using the retractor

A good broad retractor is needed together with long dis secting forceps and an aneurysm needle with a lateral curve A good light is essential A reflector will be found convenient but the most substantial aid is afforded by an electric head lamp With such a lamp as this the main difficulties of the operation are removed

The operation to be described is usually known as *Sir Astley Cooper's method* The position of the patient has been already indicated An incision 3½ inches in length is made above Poupart's ligament The cut is com menced about 1½ inches to the outer side of the pubic spine and is placed ½ inch above Poupart's ligament For the inner two thirds of its length it runs parallel with the ligament but for the outer one third it curves a little upwards away from the ligament

The skin and subcutaneous tissues are cut through, and in the latter will be divided the superficial epigastric artery and vein both ends of which should be tied

The white glistening aponeurosis of the external oblique muscle is now exposed and is divided in the line of the skin incision The knife follows very nearly the direction of its fibres The parts being retracted the surgeon seeks for the external border of the conjoined tendon, which will be made out at the inner end of the wound

The lower fibres of the internal oblique muscle are drawn upwards (Fig 35) and are divided close to their attachment to Poupart's ligament The extent of the division corresponds to the extent of muscle tissue exposed in the wound (The internal oblique is attached to the outer half or two thirds of Poupart's ligament the transversalis to the outer third only)

The fascia transversalis is now exposed and is divided transversely over the artery and as far on either side of it as is necessary

At this stage of the operation care must be *taken not to*

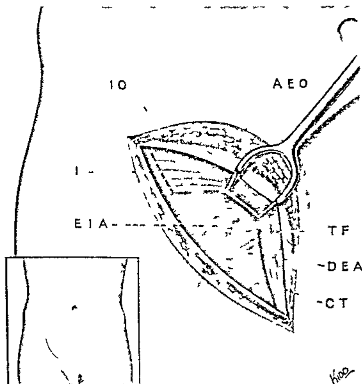


Fig 35 —Ligature of right external iliac artery

I O Internal oblique I line of incision in I O E I A external iliac artery (position of) A E O aponeurosis of external oblique T F transversalis fascia D E A deep epigastric artery (position of) C T conjoined tendon

wound the deep epigastric artery which passes—between the transversalis fascia and the peritoneum—across the wound area

The external iliac artery can now be made out The sub peritoneal tissue about the vessels should be gently loosened, and the peritoneum then with the utmost care be peeled from the artery and vein and pushed upwards in the direction of the umbilicus (Fig 36)

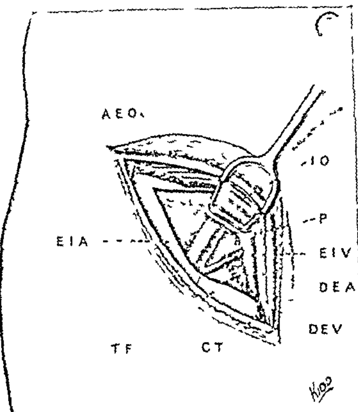


Fig 36 —Ligature of the right external iliac artery

A E O Aponeurosis external oblique E I A external iliac artery T F transversalis fascia C T conjoined tendon D E V deep epigastric vein D E A deep epigastric artery E I V external iliac vein P peritoneum I O internal oblique

The fingers alone should be employed in this process Any form of director is unnecessary and dangerous

The artery should be bared to such a height as to allow the ligature to be passed around it at a point about an inch above Poupart's ligament

The peritoneum must be kept out of the way with the broad retractor while the artery is being exposed

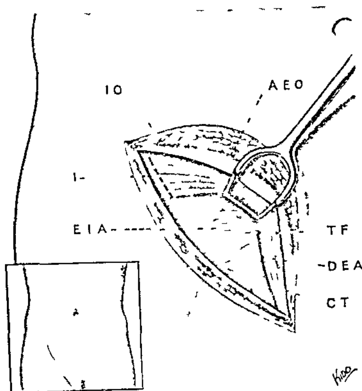


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peritoneum involves no extra risk It is simply inconvenient as it allows omentum or intestine to get in the way Should the peritoneum be accidentally incised the best course is to sew up the wound in it with a fine continuous catgut suture, then to push the peritoneal pouch upwards with finger or small sponge held in forceps, and to continue with the stages of the operation

The artery should be secured at least 1½ inches above Poupart's ligament, in order that the ligature may be well clear of the large branches given off close to the ligament, and a space be allowed for the formation of the necessary clot

The deep epigastric artery has been accidentally cut during the operation

COMMON ILIAC ARTERY

Intraperitoneal operation—A paramedian incision is made through the abdominal wall, i e running vertically upwards for about 4 inches from just above the external ring The wound is made an inch or so from the median line on the side of the artery to be tied The sheath of the rectus muscle is opened to the full extent of the incision, the muscle itself retracted outwards, and the transversalis fascia and peritoneum divided to a corresponding extent The patient should be placed in the Trendelenburg position which has the advantage of keeping the intestines out of the way Such coils of bowel as present themselves are kept away from the operation area by sponges and retractors The artery is then sought for, lying in front of the last lumbar vertebra Good illumination and efficient retraction of the wound are essential

The peritoneum over the artery is divided by a vertical incision and the vessel well exposed The needle is best passed from the vein—i e from right to left in dealing with the left common iliac and from left to right in dealing with the opposite artery

On the left side the inferior mesenteric vessels lie over the common iliac artery, and are therefore much in the way The

The loose subperitoneal tissue, which forms a kind of sheath for the artery should be cautiously cleared away

The needle is passed from within outwards

After the ligature has been secured, the divided fibres of the internal oblique may be united to Poupart s ligament and the rent in the external oblique aponeurosis be closed by a few points of buried suture

No drainage tube is required

Comment —The wound must be of sufficient length and be carefully placed

If it be made too low down there is danger of dividing the circumflex iliac vessels if made too high up of cutting into the internal abdominal ring If it be carried too far outwards an unnecessary amount of muscular tissue is divided and if too far inwards the external ring and the structures of the cord may be placed in jeopardy With care however it is easy to displace the cord upwards if necessary

The tissues must be cleanly divided The transversalis fascia should be cut sufficiently high to avoid the circumflex iliac vein but not at too great a height

Care should be taken against needlessly tearing up the sub peritoneal fatty tissue and infinite care must be taken of the peritoneum It should not be too extensively stripped up, and in clearing the artery with the finger it is possible to detach the vessel from the psoas muscle The vein has been damaged in passing the aneurysm needle and the genito crural nerve has been included in the ligature

The peritoneum has been not infrequently opened This has resulted sometimes from too high an incision because the serous membrane becomes more and more intimately connected with the transversalis fascia the farther the distance from Poupart s ligament The peritoneal cavity has also been often opened up by the incautious use of the steel director (an instrument which should never be employed in this operation) and by a too free manipulation with the handle of the scalpel

When proper asepsis is being observed a wound of the

however, the acute surgical emergency of arterial obstruction by an embolus occurs The common sites are the popliteal and the femoral and popliteal bifurcations Under favourable circumstances timely removal of the embolus will save the patient an extremity otherwise doomed by gangrene The technique of such operations varies somewhat from simple exposure of the vessel

Anæsthesia —These patients are usually in heart failure with auricular fibrillation and there is no doubt that the ideal anæsthetic is local infiltration with procaine combined with

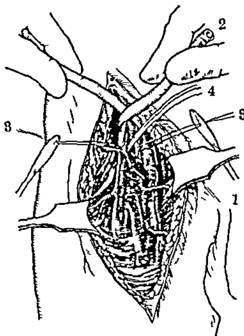


Fig 37 —Embolectomy of the femoral artery

Note 1 the embolus is lodged at the bifurcation of the vessel 2 the rubber tubing used as a tourniquet 3 the fine stitches acting as retractors and 4 the irrigator combined with extracting forceps

peritoneum must be divided to their inner side when they can be displaced outwards or forwards

On the right side no such difficulty will be met

The position of the ureter crossing the bifurcation in the subperitoneal layer should be borne in mind

The wound in the anterior abdominal wall is carefully closed layer by layer with buried sutures In this way, by employing the paramedian incision there should be no risk of subsequent ventral hernia

INTERNAL ILIAC ARTERY

Intraperitoneal operation.—The patient having been placed on the table in the Trendelenburg position, the abdomen is opened by an incision exactly the same as for ligature of the common iliac (p 69) The intestines having been pushed up and drawn aside the area of the deep wound is surrounded by sponges and so cut off from the peritoneal cavity

The peritoneum over the artery is thus well exposed and is divided to the extent of 1½ inches The artery is followed down from the bifurcation of the common iliac The vein will appear to be about three times the size of the artery and the separation of the two is a matter of some delicacy The vein indeed presents the chief difficulty in the operation Care should be taken that the ureter be not damaged nor accidentally included in the ligature The many sympathetic nerve fibres which follow the artery may be avoided if the coat of the vessel be well exposed

A good light several broad retractors or spatulæ long dissecting forceps and a variety of aneurysm needles are required The operation should be performed with the care which is essential in every abdominal section and the wound sutured layer by layer with catgut or fine thread

ARTERIAL EMBOLUS

Exposure of arteries as previously mentioned (*see* p 1) is usually performed for the purpo es of ligature Occasionally

obviously recovering from the acute crisis These cases require general medical measures
(b) Those cases which succumb before help can be obtained
(c) A small group which when first examined are very precariously hanging between life and death

It is this final group which are to be considered for pulmonary embolectomy The decision is an anxious one and the attendant may have to be prepared to watch his patient for some hours The deciding factor is the pulse Should the pulse flicker and die out, the operation must start *immediately* (hence the bed, during the waiting interval, must be wheeled into the operating theatre)

Anæsthesia —No anæsthetic is required at first If the operation is successful and consciousness returns a little, gas and oxygen may be necessary for the final stitches

Special instruments—The following special instruments are required (a) Spring forceps, to evert the incision made in the pulmonary artery, (b) rubber covered clamp to apply to the artery in its long axis while the incision is being closed (c) special rubber tourniquet with introducer, to control the pulmonary artery, (d) thrombus forceps to remove the clot

In addition rib resection instruments are required in a large hospital These instruments are best kept ready sterilized and packed in a drum labelled Arterial Embolectomy Set' This drum is re sterilized and re packed by the theatre Sister at regular intervals

Technique —A "⊢—" shaped incision is used—the horizontal limb at the level of the 2nd rib, the vertical limb from the sterno clavicular joint to the 4th rib (Fig 38) The incisions are of course bloodless as the patient is moribund The 2nd and 3rd costal cartilages and portions of the adjoining ribs are resected for about 4 inches Care is taken to avoid opening the pleura The 4th rib is exposed at the lower end of the incision and at its inner end the pericardial sac covered with some fat, is seen The pericardial sac is

preliminary narcotization by morphia It may be most important for the surgeon to have the patient's co-operation in the matter of relief of symptoms and localization of the embolus A spinal or general anæsthetic will destroy this co operation

Special equipment.—Light springed, rubber covered clamps and lengths of rubber tubing to act as temporary artery clamps a suction cannula an abundant supply of sodium citrate solution 3 5 per cent fine silk treated with petroleum jelly on eyeless needles for the arterial wall suture

Basis of procedure —The site of the embolus is localized and after infiltration of the area with procaine a free exposure of the ves el above and below the embolus is made The rubber tubing lengths are passed round the vessel above and below the site of obstruction The arterial wall is then deliberately incised and the clot evacuated by suction and irrigation (Fig 37) The patency of the vessel is tested at either end by cautious release of the rubber tubing and relief of symptoms noted The incision is carefully and accurately sutured with fine silk treated with petroleum jelly Hæmostasis is tested and the wound sutured This is the simplest technique Under certain circumstances full consideration of which is out side the scope of this book it may be wiser to modify this tech nique Most occlusions take place at the bifurcation of the vessels e g at the elbow knee etc and it may be preferable to incise the smaller branch and milk the clot from the larger ves el into it This has been brilliantly done in certain cases of embolism of the abdominal aorta at the bifurcation Both femoral arteries were opened and the clot dealt with indirectly In rare cases the clot may be side tracked into unimportant channels

TRENDELENBURG S OPERATION PULMONARY EMBOLECTOMY

Cases of pulmonary embolus from the operative aspect may be divided into three groups

(a) Those patients with smaller emboli who are

rapidly and surely as possible, remembering that during this period the dying heart is acutely embarrassed, and the circulation has been interrupted completely The thrombus forceps are passed in a horizontal direction into the right branch of the pulmonary artery and such thrombus as can be

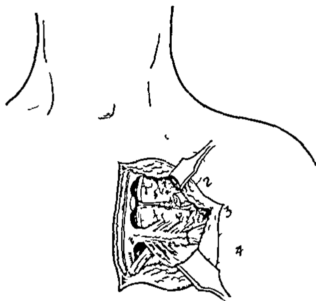


Fig 39 —Trendelenburg s operation the exposure

obtained is removed The edges of the incision in the artery are approximated and the tourniquet relaxed and the heart, which is grossly congested, is relieved while the circulation recovers for a few seconds The tourniquet is again tightened and the left branch of the artery explored The forceps pass, in this case, vertically backwards It is important to remember the different directions of these two main branches of

lifted up incised, and then steadily stretched bringing into view the contents of the pericardial chamber (Fig 39) The pulmonary artery presents swollen and pulseless The index finger of the left hand is made to encircle the base of the pul monary artery and the special tourniquet introducer is placed around the vessel This tourniquet acts both as a retractor

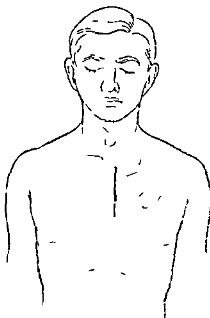


Fig 38 --Trendelenburg s operation the incision

and as an occluder of the pulmonary artery It must be remembered that the pulmonary artery is considerably thinner than the aorta and its lumen can be occluded more readily by crossing the ends of the rubber tourniquet The artery is now incised longitudinally for 1½ inches Black blood pours out temporarily until the tourniquet is applied tighter The next steps of the operation are performed as

hæmoptysis and considerable pain of pleuritic origin This pain can be controlled by injections of morphine

The patient should be nursed in the Fowler's position and movements of the legs should be encouraged as soon as the patient has recovered from the anæsthetic

Deep breathing exercises should be encouraged

the artery (Fig 40) After three attempts to clear the branch of thrombi, the rubber clamp is applied to the vessel and the tourniquet relaxed and the circulation is encouraged to return by mas age and intracardiac adrenalin The preceding stages should all have been performed in as little

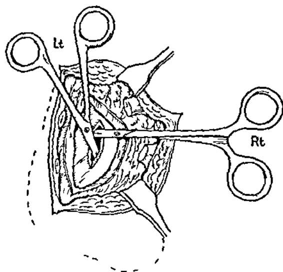


Fig 40 —Trendelenburg s operation the incision in the vessel

time as it takes to write this description The slit in the arterial wall is now sutured by fine interrupted suture The clamp is released and tests made to see that the suture line is hæmostatic Extra sutures are put in as necessary In a favourable case the circulation will by now have been restored and the patient may begin to recover consciousness and even cry out The pericardium is closed the muscles sutured and the skin closed in the ordinary way The post operative period in any successful case is likely to be marked by repeated

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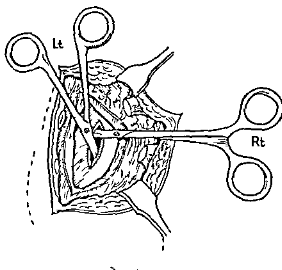


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those of mixed composition As a remedy for clonic motor spasm—for example, of the facial or neck muscles—nerve stretching is not worth resorting to, as its effects are so transitory In fact its use is limited to selected cases of true sciatica which yield to no other measures and even here the results have been conflicting It should be noted that the sciatic trunk can be stretched without open operation by forcibly flexing the patient's affected lower limb on the trunk whilst his knee is kept extended

Injection of Alcohol Into and Around a Nerve

This method is limited to cases of neuralgia especially of the fifth cranial nerve Temporary paralysis of the fifth nerve is now practised for painful lesions in the mouth in the fifth nerve distribution and also to secure anæsthesia during painful treatments in the mouth The radium bomb treatment of carcinoma of the tongue causes great pain which can be in part relieved by a preliminary nerve injection This produces an alcoholic neuritis and paralysis of the particular nerve treated, with relief to the neuralgia which may last for several months for a year, or even more

Opinion is still divided in cases of trigeminal neuralgia between alcoholic injections and section of the sensory root of the fifth cranial nerve The older operations of excision of the Gasserian ganglion or its branches (especially the second and third divisions) have been completely abandoned Most surgeons are of the opinion that one *effective* injection should be given before root section is advised, so that the patient may appreciate what the results of the permanent section will be

Injections may be of two kinds of the Gasserian ganglion itself or of its branches The ganglion is injected by an anterior route (Hartel's) the third division is injected by the same anterior route, or occasionally by a lateral approach (Harris's) while the second division is injected by Harris's lateral route The injection is performed under a local anæsthetic combined with morphia premedication

Requirements.—Hypodermic syringes, needles and 1 per

PART II —OPERATIONS ON NERVES

CHAPTER I

INTRODUCTORY

Among the many operations upon the peripheral nerves that of *neurorrhaphy* or suture of the divided ends of a nerve trunk, is by far the most frequent and important The cases of divided or injured nerves resulting from gunshot wounds in the 1914–18 War and the 1939—1945 War were exceedingly numerous and the results of operation on them have been on the whole most beneficial

Another operation frequently required as a result of the 1914—18 War was the excision of bulbous ended nerves in amputation stumps (painful neuromata) At the present time the surgeon takes great pains to avoid the occurrence of these amputation neuromata

Division of a nerve in its course (*neurotomy*), and excision of part of a nerve (*partial neurectomy*) have a few limited indications Temporary physiological section by alcohol injection is finding an increased field of usefulness

The following methods will be dealt with briefly before discussing the ways of approach to individual nerve trunks

Injection of nerves with alcohol
Neurotomy
Neurorrhaphy or suture of a divided nerve trunk
Neurolysis
Nerve avulsion

Nerve stretching

This procedure has been applied to nerves of all kinds both large and small, to motor and sensory nerves as well as to

usually necessary to protect the cornea, which is insensitive The operation of section of the sensory root of the fifth nerve is described on page 515

Nerve-anastomosis may be mentioned here the only serviceable operation being facio hypoglossal anastomosis for facial paralysis due to facial nerve injury An incision is made along the anterior border of the upper third of the sterno-mastoid muscle on the affected side This exposes the facial nerve as it emerges from the stylo mastoid foramen and the ansa hypoglossi as it lies on the carotid sheath

The ansa hypoglossi is cut and turned up to be sutured to the distal end of the facial nerve which is cut as near its point of emergence from the skull as possible The first signs of return of function may be expected in from six to eight weeks

The results of nerve grafting or anastomosis in cases of *old infantile paralysis have been far from satisfactory* Transplantation of tendons (of active muscles in a limb to reinforce the paralysed ones) or joint fixation (arthrodesis) is superior in every way

Neurotomy

Neurotomy may be done for—

(*a*) Spastic lesions (*b*) Neuralgia (*c*) Tics

For local spastic lesions the peripheral nerves are attacked division of two thirds of the obturator nerve is undertaken through an incision on the inner side of the thigh for adductor spasm (Stoffel s operation)

In severe cases and young children who are incontinent the obturator section is often performed through a median supra pubic incision The peritoneum is dissected upwards with gauze and the nerves are readily found on the lateral aspect of the pelvis Usually an inch of nerve is resected on each side Ligatures should be used as a vessel may accompany the nerve *Stoffel s* type of operation viz the reduction of spasticity by nerve section is also applied to spastic equinus The branches of the internal popliteal nerve

cent novocain and mounts 2 c c Record type syringe accurately ground to fit the set of stainless steel graduated needles with stylets 90 per cent alcohol

Technique—*Injection of the maxillary (2nd) division*—The patient sits in a chair with arm rests A line is marked out between the point where the frontal process of the malar bone bends sharply upwards and the point where the anterior border of the coronoid process forms an angle with the malar bone The skin at this latter point is infiltrated with novocain The needle is passed in for 2 inches in an inward and upward direction following the line marked out The nerve is reached at the foramen rotundum Intense pain is felt in its distribution a few drops of novocain are injected When anæsthesia is established ½ c c of alcohol is injected

Injection of the mandibular (3rd) division—The skin is infiltrated at a point 2 cm external to and above the angle of the mouth The needle is directed upwards backwards and slightly inwards It is guided by a finger in the mouth The needle is aimed to strike the infratemporal crest of the temporal bone and is then manipulated back into the foramen ovale Novocain and 1 c c of alcohol are injected as before

Injection of the Gasserian ganglion—The same route is followed as that for injection of the mandibular division The needle is made to enter the oval foramen and is pushed on for a further 1 cm The injection is made as before It is essential to see that cerebro spinal fluid is not leaking indicating puncture of the subarachnoid space To inject under such circumstances would cause paralysis of the 6th 7th 8th, 9th 10th 11th and 12th cranial nerves on that side

Comment—Great skill is called for in these injections and the beginner should practi e on the cadaver The beginner is advi ed to have a skull by him to examine during the placing of the needle The needle may be inserted into the pharynx the Eustachian tube the internal maxillary artery or the subarachnoid space An injection must not be made until the operator is certain that the needle is in the nerve or ganglion as desired and as demonstrated by the pain reference and anæsthesia When the whole ganglion is injected it is

In the *secondary suture* the steps of the procedure are as follows —

The nerve is exposed The incision is made over the course of the nerve and parallel with it

The upper end of the nerve is more easily found than the lower It is usually enlarged bulbous and sensitive

The lower end, on the other hand, is usually atrophied and filiform and is apt to be lost in cicatricial tissue and to be free from notable sensation

It may be necessary to expose the trunk of the nerve lower down and then follow the cord upwards in order to find the lower end with greater certainty

In any case the operator must be prepared to make a very free wound

Each portion of the exposed nerve should be freed for some distance respectively upwards and downwards and the ends carefully drawn up in order to bring as much of the nerve as possible into the wound area to overcome the gap resulting from retraction and to allow the extremities to be brought readily into contact All tension must be avoided

The two exposed ends are excised This is best done with a sharp knife or scissors The cut must be clean and quite transverse The bulb may be cut away layer by layer until a section of healthy nerve fibres is exposed It is not always necessary to remove the whole of the bulbous end Indeed, the firmer tissues of the bulb afford an excellent hold for the sutures The two ends are now approximated and the sutures inserted

From two to six or eight sutures will be required, according to the size of the divided nerve The material should be the slenderest consistent with strength The finest silk is probably the best The thread is passed by means of a curved needle A small intestinal needle answers admirably The needle should be introduced about a quarter of an inch from the free end of the nerve and the thread should never be carried through the whole thickness of the trunk but a small portion of the perineurium should be picked up and the suture tied

to the gastrocnemius are exposed at the lower end of the popliteal space They can be identified by the galvanic current before section The same operation has been carried out on the branches of the median nerve in the lower part of the arm to the pronator radii teres, and of the anterior interosseus nerve to the pronator quadratus to relieve pronator spasm These operations give fair results in the lower extremity but poor results in the upper

Neurotomy is occasionally performed for the various motor tics e g facial spasm though alcohol injection is usually preferred (if necessary injection at open operation) Neurotomy of sensory nerves or nerve roots (Forster s operation) may be performed in cases of intractable pain in the lower extremity These procedures have been replaced to a large extent by operations on the spino thalamic tracts (Spiller s operation) operations on the sympathetic nerves (Chap III) and alcohol injections

Neurorrhaphy

This operation effects the union of nerve trunks which have been severed by accident

The term immediate suture is applied to cases in which the divided ends of the nerve are united within a short time of the accident the term secondary suture' to instances in which a period of time varying from weeks to months has elapsed between the receipt of the injury and the operation It is needless to say that the former measure is the simpler and by far the more successful It has been asserted that primary union of the two ends of the nerve is occasionally followed by immediate restoration of function This is however a mistake due to the fact that protopathic sensation is conveyed by some other route than the divided nerve or to error in exact observation

In the *immediate suture* the wound is perfectly cleaned and the cut ends of the nerve are brought together and united by sutures Any bruised or jagged part of the exposed nerve is cut away The general features of the operation are identical with those now to be described

In the *secondary suture* the steps of the procedure are as follows —

The nerve is exposed The incision is made over the course of the nerve and parallel with it

The upper end of the nerve *is more* easily found than the lower It is usually enlarged bulbous, and sensitive

The lower end, on the other hand, is usually atrophied and filiform and is apt to be lost in cicatricial tissue and to be free from notable sensation

It may be necessary to expose the trunk of the nerve lower down and then follow the cord upwards in order to find the 'lower end' with greater certainty

In any case the operator must be prepared to make a very free wound

Each portion of the exposed nerve should be freed for some distance respectively upwards and downwards and the ends carefully drawn up in order to bring as much *of the nerve as possible* into the *wound area* to *overcome* the gap resulting from retraction and to allow the extremities to be brought readily into contact All tension must be avoided

The *two* exposed *ends* are excised This is best done with a sharp knife or scissors The cut must be clean and quite transverse The bulb may be cut away layer by layer until a section of *healthy nerve fibres is exposed* It is not always necessary to remove the whole of the bulbous end Indeed, the firmer tissues of the bulb afford an excellent hold for the sutures The two ends are now approximated and the sutures inserted

From two to six or eight sutures will be required, according to the size of the divided nerve The material should be *the slenderest consistent with strength* The finest *silk* is probably the best The thread is passed by means of a curved needle A small 'intestinal' needle answers admirably The needle *should* be introduced about a *quarter of an* inch from the free end of the nerve and the thread should never be carried through the whole thickness of the trunk but a small portion of the perineurium should be picked up and the suture tied

or fibrous tissue or muscle Ammioplastin has been used with some success

Nor is the plan of *splicing the two ends* (by turning up and down portions of the nerve) apparently of more service, the continuity obtained is only apparent *Flexion* of the joints may cause no *diminution of the gap* (e g *in* the case of the ulnar or *musculo spiral in* mid arm), and extreme flexion is never followed by good results

The best *plan is* probably to graft into the *gap* a suitable length of the long saphenous nerve from the patient The lateral cutaneous nerve of the thigh also is *readily* found (½ an inch below and medial to the anterior superior iliac spine) and is *often* used to bridge a gap in the facial nerve Of course the transplanted nerve serves only as a scaffolding for the new fibres to grow *along* from the central end but it forms by far the most suitable scaffolding and very favourable results have been obtained by this method—much better than from attempting *to drag together widely* separated nerve ends

Nerve Avulsion

Not infrequently a partial neurectomy is insufficient in an operation to secure interruption of a nerve trunk Interruption is *of course* obtained *but regeneration may* take place and the effect be only transitory Under the circumstances the nerve may be avulsed The phrenic nerve is the nerve most often avulsed at the present time The auriculo temporal nerve is occasionally avulsed These operations are described in the chapters *following* on the particular nerves

CHAPTER II

OPERATIONS ON NERVES OF THE HEAD AND NECK

FIRST DIVISION OF THE TRIGEMINAL NERVE

Maxillary nerve—This nerve gives off many important branches immediately after passing through the foramen rotundum where it crosses the roof of the pterygo maxillary fossa Hence to make a complete division or removal of the trunk it is necessary to approach it from within the cranial cavity (*see* below)

As to injection of this nerve with alcohol *see p* 80

Intracranial resection of the maxillary nerve—(Details of this operation are given on page 515) This operation has been completely replaced by that of fractional severance of the sensory root of the fifth cranial nerve

SPINAL ACCESSORY NERVE

Operation—The shoulders are raised the head is thrown a little back and the face is turned to the opposite side

An incision 3 inches in length is made along the anterior border of the sterno mastoid muscle commencing above at the tip of the mastoid process The skin and superficial tissues having been divided the anterior border of the muscle is exposed and the cervical fascia freely opened The lower border of the parotid gland in its fascial sheath is drawn forwards

The neck being relaxed a little the sterno mastoid is drawn forcibly backwards by a blunt hook or suture retractor This will serve to put the nerve upon the stretch and to bring it a little nearer to the surface

On careful examination with the finger the nerve may usually at this stage be felt The best guide to its position is the conspicuous transverse process of the atlas since the nerve crosses almost directly over that process of bone The inferior border of the digastric muscle should be defined and passing from beneath the digastric to the sterno mastoid across the site of the atlantoid process the nerve can readily be exposed by a little dissection It lies, as a rule, beneath the occipital artery and above (i e superficial and close to) the internal jugular vein on the same plane and behind the hypoglossal nerve The operator will probably be surprised to find how small the eleventh nerve appears considering that it supplies a large part of both sterno mastoid and trapezius muscles

Comment —Section of the eleventh nerve may form part of the operative treatment in severe spasmodic (clonic) torti collis Apart from this its premeditated division should never be performed In particular a strenuous warning is required against using it in nerve anastomosis (for facial paralysis) and *against the danger of damaging the nerve in* dissecting out glands from the upper part of the anterior (or posterior) triangle If the eleventh nerve has been damaged in either of these procedures in the anterior triangle the corresponding shoulder drops the movements of both shoulder and arm become impaired and a permanent deformity remains It should also be noted that the results of facial with spinal accessory anastomosis have been very indifferent in other ways

Avulsion of the Phrenic Nerve

Operation —The patient is placed in the supine position with the shoulders raised and the head thrown back and turned to the opposite side A local anæsthetic is employed An incision is made along the posterior border of the sterno mastoid muscle in its lower third the mu cle is retracted inwards and *the outer border of the* scalenus anterior muscle defined This is best done with the finger by feeling the muscle insertion onto the scalene tubercle on the inner side

of the rib The phrenic nerve cannot be seen until a dense layer of fascia surrounding the muscle is incised and then it is found crossing in a downward and slightly inward direction (Fig 41), the nerve is cut and the distal end steadily

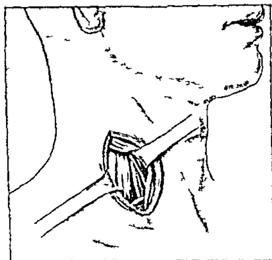


Fig 41 —Exposure of the phrenic nerve on the right side

avulsed by winding it round a pair of pressure forceps Avulsion rather than simple neurectomy is practised in order to prevent regeneration and more especially to catch the contribution from the fifth cervical nerve to the phrenic which comes off from the nerve to the subclavius muscle Avulsion is the only certain method of securing this branch In order to arrest the diaphragm temporarily the nerve may be crushed with Wells forceps Some surgeons advocate crushing the nerve through the fascia overlying it in case the operation needs to be repeated at a later date

Many errors have arisen in the operation The commonest is to work too superficially and pick up one of the supraclavicular nerves Branches of the costo-cervical trunk of vessels may also be troublesome If working too medially

the vagus may be mistaken for the phrenic nerve if too laterally the brachial plexus may cause error When the phrenic nerve is pinched with forceps not only does the patient experience sudden pain in the shoulder but the diaphragm on that side gives a jerk

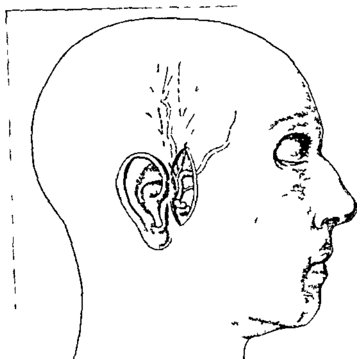


Fig 42 —Exposure of the auriculo temporal nerve as it lies behind the superficial temporal artery

The upper part of the pa oti l glai d can l e cen at the lower end of the in isi n

Comment —The object is to paralyse the diaphragm thereby securing rest for the affected lung in cases of active utberculosis or bronchiectasis it may be used as a prelim

inary to thoracoplasty Nowadays phrenic interruption is usually accompanied by pneumoperitoneum which elevates the paralysed diaphragm Otherwise paradoxical movement is apt to occur The operation is sometimes used for hiatus hernia and has been used for intractable hiccoughs Crushing the nerve causes the diaphragm to be paralysed for six months

Avulsion of the Auriculo temporal Nerve

Operation —A vertical incision 1 inch long is made in front of the ear and behind the superficial temporal artery with its mid point crossing the zygoma, this exposes the nerve as it lies behind the artery (Fig 42) The nerve is divided and the proximal end avulsed

Comment —This operation may be required in cases of persistent parotid fistulæ following injury to Stenson s duct It is true that all the secretion is not abolished as there still remains a paralytic secretion but this is very slight and does not prevent the healing of the fistula The operation is only indicated when plastic operations and X radiations have failed

the vagus may be mistaken for the phrenic nerve if too laterally the brachial plexus may cause error When the phrenic nerve is pinched with forceps not only does the patient experience sudden pain in the shoulder but the diaphragm on that side gives a jerk

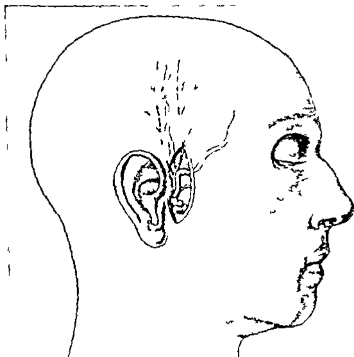


Fig 42 —Exposure of the auriculo temporal nerve as it lies behind the superficial temporal artery

The upper part of the [illegible] gland can be seen at the lower end of the [illegible]

Comment —The object is to paralyse the diaphragm thereby securing rest for the affected lung in cases of active utberculosis or bronchiectasis it may be used as a prelim

above the internal condyle The incision is from 2 to 3 inches long passing upwards from behind the internal epicondyle slightly forwards The nerve is found to lie along the back of the internal intermuscular septum with the superior ulnar collateral artery, which is placed to its outer side The nerve in young subjects is liable to pressure from a detached internal epicondylar epiphysis which it may be necessary to fix in place, when manipulative methods have failed to reduce it

3 Just above the wrist the nerve may be exposed by means of an incision 1½ inches long made parallel to the tendon of the flexor carpi ulnaris and to its outer side After the integuments and fascia have been divided the nerve is brought at once into view the artery lying to its radial side

Transposition of the Ulnar Nerve

Traumatic neuritis of the ulnar nerve is a well recognized entity It is usually associated with injuries and fractures of the elbow region especially those which are left with the deformity of cubitus valgus The signs of neuritis may not be apparent until many years (twenty or more) after the injury The condition is readily treated by anterior transposition of the nerve and this is a most satisfactory procedure

Operation—A 5 inch long curved incision convex posteriorly, is made centred on the sulcus ulnaris A tourniquet should not be used The skin and fascia are dissected freely in front of the elbow The nerve is found in the sulcus ulnaris and is freed for at least 2½ inches above and below, though branches from the nerve must not be divided A bed is made for the nerve in the brachialis muscle above and the superficial flexors below The nerve is laid in this bed and the fascia united over it The skin is closed in the usual manner

Comment.—It is useless simply to place the nerve in front of the epicondyle in a subcutaneous position The nerve must be freed and a proper bed made for it The nerve otherwise is almost as vulnerable as in its normal position and the neuritis will not regress Adequate freeing

CHAPTER III

OPERATIONS ON NERVES OF THE UPPER AND LOWER EXTREMITIES AND THE SYMPATHETIC NERVOUS SYSTEM

MEDIAN NERVE

Operations—1 In the arm the nerve can be exposed through such an incision as is employed to secure the brachial artery e g in the middle of the arm The nerve is occasionally exposed in this situation to divide the branch to the pronator teres in cases of pronator spasm

2 At the wrist it is readily exposed through an incision about 1½ inches in length which is parallel with the tendon of the flexor carpi radialis and close to its ulnar side A superficial vein or so may be cut the fascia is divided and the nerve can at once be brought into view This approach can be deepened to give access to the anterior interosseous branch of the median as it enters the pronator quadratus

The nerve lies close to the tendons of the flexor sublimis digitorum In a transverse wound of the wrist both nerve and tendons are liable to be divided and care must be taken in suturing to distinguish between them as mistakes have occurred and one end of the cut nerve has actually been sewn to a tendon

ULNAR NERVE

Operations—1 Above the centre of the arm the nerve may be exposed by an incision parallel to the line of the brachial artery and half an inch to the inner side of it In exposing the nerve care must be taken to avoid injury to the venæ comites of the brachial artery the intercosto brachial and the ulnar collateral nerve all of which are in near association with the trunk sought

2 The ulnar nerve is very conveniently exposed just

with his forefinger seeks for the nerve as it lies close to the bone, piercing the intermuscular septum and about to cross the upper limit of the supinator muscle If the fibres of this muscle be exposed the position of the nerve can be more readily determined. The supinator muscle may be drawn outwards so as to demonstrate the groove between it and the brachialis anterior The nerve may be carefully separated from the companion artery and drawn forwards by means of a blunt hook.

On the living subject this nerve is usually sought for as it winds round the humerus and it may be necessary to lift it out of a groove of callus or even to chisel away some of the callus The incision to expose the nerve here would be made longitudinally through the triceps muscle and after freeing the nerve some fibres of the muscle should be placed between it and the bone to protect it from further pressure

Sciatic Nerve

Operation —The nerve is most accessible for stretching if exposed at the lower border of the gluteus maximus muscle, just as it is leaving the hollow between the tuber ischii and the great trochanter This corresponds to its most superficial part

The patient should be turned sufficiently over upon the face to enable the buttock to be exposed and the thigh to be extended A vertical incision 4 inches in length is then made in the course of the nerve

The incision should commence over the gluteal fold and should be exactly over the middle of the interval between the tuber ischii and the great trochanter If the wound be made nearer to the tuber there is an increased difficulty in displacing the hamstring muscles

The centre of the incision will about correspond to the free lower margin of the gluteus maximus

The skin and fascia having been divided the posterior cutaneous nerve of the thigh and a few cutaneous arteries will be encountered The quantity of the subcutaneous fat may be considerable

of the nerve is only limited by its twigs It will be remembered that the ulnar nerve has no branches in the arm The nerve

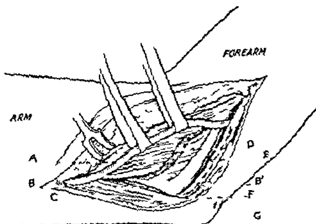


Fig 43 —Transposition of the ulnar nerve

A Ulnar nerve lifted forward BB original b d of nerve C triceps D fascia and muscle split to form new nerve b d E flexor c rpi ulnaris split in order to lift nerve F internal epicondyle of humerus G olecranon

throughout must be treated with the greatest delicacy It is best controlled by a piece of sterile tape under it Its sheath may be handled with fine catch forceps (Fig 43)

RADIAL NERVE

Operation.—The nerve is most conveniently exposed at the point at which it gains the outer side of the arm The elbow is flexed and the arm carried a little across the patient s thorax

An *incision* from 2 to 2½ inches in *length* is made *obliquely* across the outer surface of the arm at its lower third

The centre of the *incision* is made to correspond to a point midway between the insertion of the deltoid and the external condyle, and its obliquity is so determined that the lower part of the incision will follow the line of the upper border of the brachio radialis

The skin and fascia having been divided the surgeon

still to some extent experimental and final conclusions have yet to be drawn A dogmatic summary is given below It *is assumed that after the diagnosis has been made, suitable* investigations are made to confirm the absence of gross organic disease Only four types of operation will be described and the summary gives for each of these operations what may be termed Absolute Indications (where benefit may be expected) and Relative Indications (where benefit may be hoped for—an important difference)

Type of Operation	*Absolute Indications*	*Relative Indications*
(1) Cervico-dorsal ganglionectomy	Raynaud s disease	Causalgia Acrocyanosis
Syn *Stellate* ganglionectomy	*Hyperidrosis*	Angina pectoris Ménière s syndrome
(2) Lumbar ganglionectomy	Raynaud s disease Buerger s disease Callous ulcers.	Ulcers after polio myelitis. Hirschsprung s disease
(3) Thoracolumbar sympathectomy	Malignant hypertension	Relief of pain in pancreatic disease
(4) Presacral neurectomy	Cord bladder Dysmenorrhœa (certain *forms*)	Combined with the abdomino perineal *excision* of the rectum
(5) Periarterial *sympathectomy*	Painful ulcers in old *subjects* Pre gangrenous states	

Lumbar sympathectomy.—The extraperitoneal incision is the most popular particularly if only one side has to be attacked If both sides have to be done they may be done at one session by the transperitoneal route

The extraperitoneal route—A Mayo incision similar to that for nephrectomy is made and the incision deepened to reach the psoas muscle The peritoneum is stripped forwards and inwards carrying the ureter with it (Fig 45) The inner

The lower border of the gluteus maximus should be clearly exposed as it runs obliquely downwards and outwards The edge of this muscle must be drawn upwards by means of a strong and broad retractor

The finger introduced into the wound will now encounter the hamstring muscles a little below their origin from the tuber ischii These muscles should all be drawn inwards their fibres having been first relaxed by bending the knee They are retained in position by another strong and broad retractor

The nerve should now be readily discovered and brought into view the finger should be passed under it and steady traction made in both directions with care not to use too much force a useful guide being that no more force should be exerted than is required to raise the limb from the table by traction on the nerve In the living subject the operation is only performed for intractable sciatica—perhaps rheumatic in origin—and search should be made for abnormal adhesions around the nerve If found they should be divided, the nerve being isolated for as great a distance in both directions as is practicable

In wounds involving the sciatic nerve the latter is hardly ever completely divided and it has been found that the lateral popliteal segment is most apt to be involved Operations for its restoration are rarely successful

Popliteal Nerve

This nerve is exposed by an incision along the biceps tendon under cover of which it lies It is most apt to be damaged at its lower part where it winds round the neck of the fibula In performing tenotomy of the biceps tendon care should be taken not to damage the nerve the only safe way is to make an open incision and thus to expose both before cutting the tendon

Operations on the Sympathetic Nervous System

Indications.—It is not proposed in this book to deal with the indications in any detail as these operations are

incision is made 2 inches above the umbilicus the abdomen is opened and the intestines are packed off The peritoneum of the posterior wall is incised on the left side lateral to the descending colon and upper part of the sigmoid The colon is mobilized over to the right Its blood supply is carried with it and also the ureter which adheres to the peritoneum This fact should be verified, as on rare occasions the ureter does not come up with the peritoneum The inner border of the psoas muscle is sought and the lumbar chain is found lying between it and the bodies of the vertebræ At the upper end the duodenum may have to be retracted gently to allow access to the second lumbar ganglion The chain is divided just above the second lumbar ganglion and gradually dissected downwards Hæmorrhage may be troublesome from small veins and it is advisable to make free use of Cushing's clips The downward dissection ceases at the level at which the gangliated cord passes behind the iliac vessels The colon is allowed to fall back into place and the peritoneum is sutured

A similar route can then be used on the right side by incising the peritoneum to the outer side of the cæcum and ascending colon with mobilization of the gut inwards Then, proceeding as on the left side the gangliated chain is found lying between the inferior vena cava and the vertebral bodies To save displacing so much gut a more direct approach may be used on the right side The root of the mesentery is identified and an incision made just to the right of it over the vena cava Care has to be taken to avoid the spermatic vessels the ureter the vessels in the mesentery and the duodenum The inferior vena cava is identified and retracted, and the operation proceeds in the usual manner

Cervico dorsal ganglionectomy.—Only the anterior approach to the cervical ganglion will be described

The stellate ganglion must be removed in treating angina pectoris and Ménière's syndrome The second thoracic ganglion with the nerve of Kunz must be removed for vaso motor disturbances of the upper limb Removal of the stellate ganglion is unnecessary and indeed not advised in

border of the psoas is defined and on the right side the inferior vena cava The sympathetic trunk is searched for on the sides of the vertebral bodies and as much as desired is removed The lumbar vessels cross the trunk and make the operation difficult if they are torn

The transperitoneal route—A 6 inch left paramedian



Fig 44—Lumbar sympathectomy the incision

Fig 45—Lumbar sympathectomy the extraperitoneal approach to the right lumbar gangliated chain

view of the development of Horner s syndrome A collar incision is made just above the clavicle over its inner two thirds (Fig 46) The external jugular vein is sought for and divided between ligatures and the clavicular head of the sterno mastoid divided until the internal jugular vein is visible The posterior belly of the omo hyoid is divided and the scalenus anterior and phrenic nerve are defined The scalenus anterior is divided at its insertion and the phrenic nerve drawn inwards This exposes the subclavian artery which is dissected to free its upper border The thyroid axis may be divided between ligatures if necessary The subclavian artery is drawn down wards and forwards and Sibson s fascia divided along the inner border of the first rib exposing the pleura By gauze dis section the pleura is stripped in a forward and outward manner off the first three ribs and adjacent vertebræ The inferior cervical ganglion is seen lying on the neck of the first rib and from it the trunk of the sympathetic runs on the heads of the ribs (Fig 47) The trunk is secured between Cushing s silver clips at the level of the third rib and freed upwards by cutting its branches It is cut across just above the level of the inferior cervical ganglion a strip of tissue some 2½ inches long being removed The wound is closed with a small drain which is removed after forty eight hours The development of Horner s syndrome shows a successful extirpation

Presacral neurectomy.—A subumbilical median in cision is made, the abdomen opened and the viscera examined The patient is tilted into a high Trendelenburg position and the intestines are packed off upwards and leftwards The interiliac triangle made by the two common iliac arteries the bifurcation of the aorta and a horizontal base at the level of the sacral promontory is defined (Fig 48) The peri toneum over the centre of the triangle is picked up incised vertically and the bifurcation of the aorta exposed Starting in the mid line at the level of the sacral promontory the dense connective tissue about 1 inch wide is dissected off the anterior aspect of the fifth lumbar vertebra up to the bifurcation of the aorta The dissection is strictly mid line and on no account must it diverge to the left as this would



Fig 46 —Anterior approach to the stellate ganglion the incision

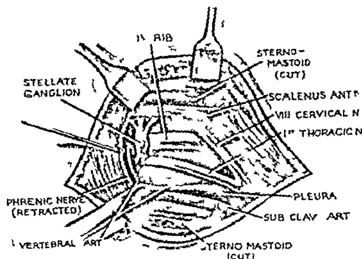


Fig 47.—Anterior approach to the stellate ganglion
Note the close relationship to the first rib

Periarterial sympathectomy.—Sympathetic denervation operations were being performed long before the exact anatomical pathways had been worked out This was one of the factors which led to confusing results in the earlier investigations Many surgeons believed that the sympathetic control of the vessels of a limb passed into the limb with the main vessels and was distributed along the branches of the main vessels to the all important smaller vessels Actually, this is incorrect The main vessels entering the limb do have a perivascular sympathetic network which constitutes their own nerve supply but this does not pass down the limb branching and subdividing with the smaller vessels Thus in the lower limb the perivascular sympathetic control ends at about the bifurcation of the common femoral artery Below this level the sympathetics enter the vessels by twigs from the somatic nerves which have non medullated sympathetic fibres in them Hence it is impossible to denervate a limb of sympathetic fibres by performing a periarterial denervation The discovery of these anatomical facts led to the temporary abandonment of the pioneer operations of periarterial sympathectomy

While it is undoubtedly true that this is a very incomplete procedure and should not be used in for example Raynaud s disease or Buerger s disease in some other conditions the periarterial operation has its merits The basis is empirical rather than anatomical The supreme advantage of the periarterial operation is the ease with which it may be performed and the fact that it can be performed under a local anæsthetic Elderly patients on whom one would hesitate to perform a ganglionectomy may readily be submitted to the periarterial operation While the benefit may be only transitory —a few days to a few months—yet this period may be sufficiently long to allow healing of an ulcer or demarcation of a gangrenous area Again the periarterial operation relieves pain though the manner of this relief is not understood Further the relief of pain is less transitory than any of the other beneficial effects of the operation e g improving the blood supply The periarterial operation thus

include the parasympathetic motor supply to the colon and rectum The strip of connective tissue removed contains the presacral nerve The posterior peritoneal incision is closed

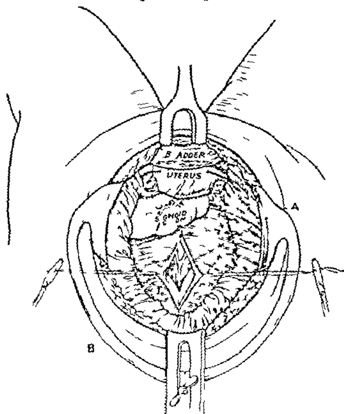


Fig 48 —Resection of the presacral nerve operative exposure

The nerve fibres A (sacral plexus) are lying strictly in the mid line and may surround the middle sacral vessel The patient is in the high Trendelenburg position B left common iliac artery

and then the packs are removed and the abdomen is closed in layers It will be noted that the operation is strictly *more* prelumbar than presacral

PART III — AMPUTATIONS

CHAPTER I

METHODS OF PERFORMING AMPUTATION

Indications for amputations.—The indications for amputations may, in general be grouped under the following headings

- Trauma
- Gangrene
- Osteomyelitis and arthritis
- Sarcoma and other tumours of bone
- Aneurysms
- Deformities of various types
- As an examination exercise

Trauma calls for amputation particularly when the main vessels to the limb are divided or the main nerve is severed or when hopeless pulping of the tissues has occurred These are generally absolute indications for a primary amputation

Trauma is the first and foremost indication for amputations in modern warfare

In *gangrene* some form of amputation has usually to be performed and the various indications and suitable sites are outside the scope of this work Gas gangrene should not be overlooked as a cause for immediate amputation

In *osteomyelitis and acute arthritis* it is usually said that amputation may be necessary in the acute phases to preserve the patient's life We feel that this is a phrase copied from book to book and personally we have never performed such an amputation and would hesitate to recommend it Amputation may however be necessary in chronic cases where amyloid disease is threatening or the ultimate function of the limb is so poor that the patient would be better served by an

finds its best application in cases of senile gangrene and painful pregangrenous conditions The periarterial operation may be applied to cases of causalgia but in this exceedingly stubborn condition the major denervation of cervico thoracic ganglion ectomy is probably preferable

The vessel (e g common femoral) is exposed under local *anæsthesia for the maximum length The arterial sheath* is opened and the tunica adventitia carefully peeled off for about 2 inches The stripping must be thorough as most of the nerve fibres are on the deep aspect of the outer coat The coat of the vessel is then painted with 90 per cent alcohol to destroy any remaining fibres The only danger of the operation is the removal of too much tissue with the risk of immediate rupture or the production of an aneurysm If too little outer coat is removed the patient will not benefit

The surgeon's choice as to the site of amputation and the mode of amputation will depend upon a variety of factors As a general principle it may be stated that in the upper limb conservation of tissue is to be aimed at in the lower limb a sound stump for a prosthesis to carry the patient's weight The flaps chosen may have to be modified for various reasons Skin lacerations may be present in accident cases at the very area where the flaps would be taken and instead of antero posterior flaps it may be desirable to use equal lateral flaps or even one long flap and one short one The surgeon has 'to cut his coat according to his cloth' In amputation for gangrene circular methods are preferable and there is then little risk of further gangrene as might occur with long flaps of dubious vitality Again circular amputations are very satisfactory in the upper arm and thigh where there is only one more or less centrally placed, bone In the leg and the upper part of the forearm where there are two eccentric bones flaps are preferable

At this stage the simplest of all methods 'the guillotine" method may be considered This was popular during the 1914–18 War as a rapid method of amputation in cases of extreme gravity such as gas gangrene Its value in the war was doubtful and it has no indications in civil practice It must not be compared with the circular method for with the guillotine all the tissues are divided flush at the same level and no attempt is made to close the skin Primary skin traction should be applied to prevent retraction of the wound A planned re amputation at a later date is nearly always essential Infection of the guillotine stump is almost inevitable and much further loss of tissue may result

§ 1 **Circular method**—In this method of amputation the soft parts are divided by a series of circular cuts made from the skin down to the bone The tissues are not divided by one sweep from integument to periosteum but by successive cuts in such a way that the skin and the layers of muscle are severed at different levels

Two forms of circular amputation are practised at the present day They are identical in principle and their

artificial appliance Cases of tuberculous osteitis and arthritis come into this category

Bone tumours of which the most dreaded are sarcomata provide clear cut indications for palliative amputation to prevent pain pathological fracture and possible fungation

Aneurysms of peripheral vessels now almost a rarity used to provide a fruitful source of amputation cases amputation being performed when either gangrene was threatening or the aneurysm appeared too formidable to be dealt with by the various ligature methods

Many congenital *deformities* and some acquired ones are best treated by an amputation particularly in the lower limb where a well made prosthesis is better than a flail limb some two or three inches short

Note —Surgeons differ much as to the respective merits of the various methods of amputation nor is there any final authority to which one can appeal except that of practical result One operator may obtain very good results from a method which another condemns The opinion of the *maker of artificial limbs has also to be considered to a certain* extent

The student is recommended to read with care the following chapter and to be content with mastering the details of *one* good method of amputation at each of the principal sites of operation

The following are the principal procedures in amputation —

1 Circular method
2 Modified circular method
3 Elliptical method
4 Oval or racket amputation
5 Amputation by flaps
6 Guillotine amputation

This order is by no means that of respective merit the fifth (the flap method) is the most generally useful while the racket method in certain positions is unquestionably the best

circle is then reflected in the form of two imperfect skin flaps

ii Two vertical incisions are made to join the circular wound By this use of the knife two square skin flaps can be dissected up and the muscles when exposed can be divided by a circular sweep of the knife

iii Two short flaps, of semilunar outline and of equal width and length are dissected up They are composed simply of the skin and the subcutaneous tissues

The skin beyond the bases of the little flaps is then retracted as a whole just as in the usual circular amputation When the retraction has been carried to a sufficient extent, the muscles are divided by circular incisions in the usual way

3 **Elliptical method** —This method occupies an intermediate position between the circular operation and the amputation by a single flap

The incision in the skin is elliptical or lozenge shaped The position and inclination of the ellipse vary according to the site of the amputation and have to be carefully estimated The skin and subcutaneous tissues are then retracted by gliding as in one form of amputation at the wrist, by the turning up of a cuff, as in the disarticulation at the elbow by a posterior ellipse or by the separation of a definite flap, as in Guyon s supramalleolar amputation

The muscles are usually divided as in the circular operation They may be however cut in part by transfixion, as in the disarticulation at the elbow by an anterior ellipse

The elliptical method is well adapted for amputations through certain joints—for example the elbow and wrist

4 **Oval or racket method** —The skin incision takes the form of an oval with one end pointed or of an isosceles triangle rounded at its base The edges of the resulting wound are united in its long axis The soft parts beneath the skin are divided down to the bone by cutting from without inwards This operation is illustrated on a small scale by some amputations at the joints of the fingers and toes

The racket method is best illustrated by disarticulation at the metacarpo phalangeal and metatarso phalangeal lines

differences such as they are depend upon anatomical features and are indeed influenced only by locality

i The ordinary circular amputation is illustrated by an amputation through the arm or thigh In these parts the bone is more or less evenly surrounded by thick muscles After each circular cut the soft tissues are allowed to retract or are retracted before a second sweep is made with the knife The result is that the wound becomes funnel shaped the edge of the funnel is formed by the divided skin the apex of the funnel or infundibulum by the divided bone

ii The circular amputation is adapted for parts where the covering of the bones is scanty and is composed of irregular tissues Such a region is best illustrated by the wrist where the bones are surrounded by many tendons and where muscular tissue is scanty and unevenly disposed

In this method of amputating the skin and subcutaneous tissues are turned up in the form of a cuff and turned back like the cuff of a coat

The skin is divided as in the previous operation by circular incision and is then together with the subcutaneous tissues turned back The turning back of this cuff is mainly effected by the fingers of the surgeon s left hand The skin is freed by the knife which should always be held perpendicular to *the surface The cuff is not dissected up It is gently freed* and turned up If the knife be passed obliquely beneath the skin which has to be everted *this is apt to be needlessly* damaged

The cuff must be even and regular and of a size previously determined

The soft parts are then divided by a circular sweep with the knife at the level of the retracted and everted skin. Finally the bone or bones are sawn through as high as the retracted tissues allow

2 **Modified circular method** — Three important modifications need to be described i In addition to the circular cut through the integuments a vertical incision is made to join the original wound The skin on either side of this vertical cut and at the points where the cut joins the

think of the position of the main artery so as to place it in one or other of the flaps (e g the superficial femoral or the brachial) We advise the beginner to mark out carefully

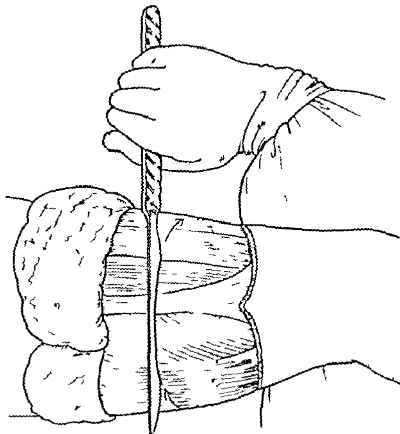


Fig 49 —The tour de maitre method of dividing the muscles by one circular cut

The surgeon is standing between the thigh and the reader's eyes

the outlines of the skin incisions with an indelible pencil before taking the knife in hand Were this done it would sometimes prevent deplorable mistakes in amputating both

of joints and is also illustrated by certain disarticulations at the shoulder and at the hip joint It gives admirable results

5 **Flap method.**—Any flap or flaps may be composed of the integuments only or of the integuments and the subjacent muscular tissue

In ordinary amputations muscle is not included in the flaps The muscle simply changes to fibrous tissue and a less supple scar is obtained

In every flap the skin must be cut longer than the muscle tissue A flap containing too much muscular tissue is unwieldy it is difficult to adjust and the muscle is certain to protrude In endeavouring to bring the edges of the skin together undue strain is apt to be placed upon the sutures

In actual practice the only muscle containing flap still used is in Farabeuf s amputation of the leg (amputation at the site of election by a long external flap) Here the tibialis anticus extensor longus digitorum and peronei are carefully preserved in the flap because running in the muscles is the anterior tibial artery—the source of supply to the long flap The total length of the flap or flaps should not exceed the diameter of the bone at the point of section pre antiseptic days demanded an additional third

Amputations through the limbs require the use of a tourniquet and a drainage tube for 24–48 hours the limb should be controlled with a suitable splint after operation A slab of plaster of Paris can be used instead of a splint After healing has taken place, daily movements should be initiated

In many positions it is convenient to make two flaps They should rarely be made of equal length and the longer one of the two should contain if practicable the chief blood vessels These flaps must be of equal width (i e half the circumference of the limb) at their base and should be evenly rounded at their lower end (in Teale s amputation the flaps are squared)

In planning out the amputation lines it is necessary to

1 **The choice of level of bone section**—This is the first thing to decide in any amputation The various factors which govern this choice are discussed in the sections dealing with the individual amputations The diameter of the limb is measured at this level

2 **The planning and raising of the flaps**—This has been discussed above

3 **Division of the soft parts**—Care must be taken to do this cleanly A small scalpel is used for raising the skin flaps but a large amputation knife gives cleaner section of bulky muscles The tour de maitre manœuvre should be employed where suitable (Fig 49)

4 **Division of the bones**—The muscles must be protected with cloth and metal retractors The bone is sawn through steadily and uniformly care must be taken not to fracture the last portion When there are two bones it is usual to divide the more fragile one first At the commencement the periosteum is slightly cleared but no special notice need be taken of this structure i e there is no need either to strip it or to try to dissect a periosteal cuff The surgeon draws the saw towards himself to commence the cut and does this two or three times until a cut is made for the sawing proper to commence No spur should be left at the end of the operation

5 **The vessels and nerves**—These are sought for and secured with artery forceps The nerves are cut across with a sharp knife No crushing or ligaturing of a nerve should ever be attempted as these are important factors in the causation of neuromata The vessels are tied and the tourniquet cautiously released Further vessels will then usually be apparent in the muscles They are secured in the usual manner Main blood vessels must be divided at right angles

6 **Closure**—The wound is swabbed with flavine and then the flaps are stitched together A drain should be left in all major amputations for 48 hours to allow serum and minor hæmorrhages to escape Careful co aptation of the skin flaps is essential

on the living subject and in the amputating room Neglect of this precaution does not imply superior skill or knowledge Again, careful measurement of the diameter of the limb and of the two flaps with a steel tape before planning the incisions is no pedantic precaution if it ensures a perfect result When a tourniquet is used allowance should be made for the extra retraction of muscles and skin which may occur when it is removed

In s parating a flap by *dissection* the flap is first marked out as described or by the eye of the surgeon and then the line is deliberately traver ed from one end to the other with the knife which penetrates only the skin and superficial fascia The other flap (if there is to be one) is marked out in precisely the same way When the integuments have sufficiently and evenly retracted the muscular part of the flap is cut with great care The knife is passed obliquely through the muscle to the bone and the soft parts forming the apex of the flap having been completely divided the rest of the deeper tissues of the flap are very carefully dissected up or peeled off from the bone

There is no doubt that cutting flaps in the manner described gives better results than tran fixion The only point gained in the latter was rapidity of execution, which counts for little or nothing in these days of anæsthetics But transfixion (cutting the flap from within outwards with a long slender knife used with a steady sawing movement) is sometimes employed for part of the operation e g for the short posterio flap made in amputation just above the knee joint

The Stages of Amputation

These may be summarized under the following six headings

1 The choice of level of bone ection
2 The planning and raising of the flaps
3 Division of the soft parts
4 The sawing of the bone or bones
5 Securing the ve sels and nerves
6 Closure

CHAPTER II

AMPUTATION OF THE FINGERS AND THUMB

General considerations —The position of the phalangeal joints must be clearly defined

In performing these operations every care should be taken to remove as little of the digit and especially of the thumb and index, as possible A short and somewhat ungainly looking stump of the thumb or of the forefinger may prove to be of the greatest value

If the thumb or a portion of it be left it is important that it should have something with which to come into apposition and in fulfilling this need the slightest stump of the forefinger is of considerable service The little and ring fingers are of less importance, provided that the other digits remain but in cases where the three or the two other fingers have been removed the little finger or the ring finger has been capable in conjunction with the thumb of performing most valuable and most complex functions

A hand with nothing left but the stump of a thumb and of a little finger is more useful than the most elaborate artificial limb

The bone should always be divided as low down as possible If only the base of the terminal phalanx can be saved it will secure for the finger the attachment of the flexor profundus tendon

Amputation of the second phalanx (Fig 50) should be performed *through* the bone whenever possible If the upper half or even the upper third of the phalanx be left some portion of the insertion of the flexor sublimis will be saved

The main points to be considered in *the selection of a method* are the following —

1 The least sacrifice of the healthy tissues of the limb

2 The providing of a good and permanent covering for the bone which moreover should not adhere tightly to it

3 The obtaining of as small a wound area as is consistent with the proper performance of the amputation

4 The securing of a good blood supply for the flaps or tissues which will form the stump

5 The production of a well adjusted cicatrix and one so placed as to be removed from pressure when the stump has healed

6 The ease with which the bone can be exposed at the saw line and the general simplicity of the method

7 The cutting of the main vessels transversely

8 The actual prosthesis to be worn

position (Fig 51) the finger to be removed An assistant is placed opposite to the surgeon He holds the patient's hand in the required position, and keeps the sound digits out of the way

Amputation or Disarticulation of the Phalanges of the Fingers

These operations include amputations through the proximal middle or terminal phalanges, and disarticulation at the first or second inter phalangeal joints

Amputation of terminal phalanx (Fig 51) — The terminal interphalangeal joint line is one twelfth of *an inch distal to the prominence of the head of the* adjacent phalanx A narrow bladed finger knife being used a dorsal incision is made right into the joint with a gentle sawing movement the phalanx is strongly flexed and the cutting edge of the knife is turned to its tip and made to cut along the palmar surface of the phalanx When this palmar flap is sufficiently long the knife is made to cut out thus making the end of the flap square Three interrupted silkworm gut sutures will suffice for approximation

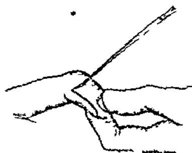


Fig 51 — Mode of holding the finger during disarticulation of the last phalanx

The proximal interphalangeal joint is one sixth of an inch distal to the prominence of the head of the proximal phalanx and the metacarpo phalangeal joint is one third of an inch distal to the prominence of the knuckle In amputating at the proximal interphalangeal joint the extensor tendon should if possible be sutured either to the flap or periosteum this ensures—

1 Flexion by the lumbrical muscles
2 Extension by its own action

As the bones of the finger are comparatively large in relation to the surrounding soft parts the flaps must be cut comparatively long Thus a single palmar flap should be equal to one diameter and a half of the digit If unequal dorsal and palmar flaps are cut the palmar flap should be longer than the diameter of the digit, while the dorsal flap should be about *one third the length of the palmar*

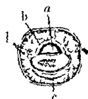


Fig 50 —Horizontal section through the middle of the second phalanx

a Flexor t n l b f b r s sheath f t l r ext r te lo d di it l a t ry a l nerve

Flaps should be so cut that the cicatrix is removed from pressure The scar therefore should not be on the extremity of the stump nor upon its palmar aspect but always upon the dorsum if possible

For this reason a single palmar flap or a predominating palmar flap (when two are cut) represents the best method in amputation through the fingers The stump which results is covered with firm and vascular skin well able to withstand pressure and is endued with the remarkable sensibility of the part A dorsal flap involves a covering for the stump which is thin ill supplied with blood little able to withstand pressure and of slight sensibility

Instruments required —Narrow slender and strong *scalpels a fine keyhole saw or a very small Butcher s saw* bone forceps dissecting and Well s artery forceps strips of gauze to hold aside the fingers *scissors needles etc*

Position —The surgeon sits with the patient s hand before him The limb should be in the position of pronation while dorsal incisions and flaps are being made and in supination during the fashioning of palmar flaps

In the *oval operation* the limb may be kept pronated throughout and disarticulation is in any case conveniently effected in that position

The surgeon holds with his left hand placed in the supine

dorsum and is carried first across one side of the root of the finger and then across the other side The incision is completed by the transverse palmar cut Three separate cuts with the knife are therefore required The incision should at first involve the skin only

The finger is now extended to its utmost and the palmar incision is carried to the bone the flexor tendons being thus stretched and divided

The finger being then turned to one or the other side the lateral incisions—on each aspect of the root of the finger—are carried to the bone In this way the digital arteries are cleanly divided, and the expansions from the lumbricals and interossei are cut Each digital artery is seized with Wells s forceps

The assistant now takes the finger while the surgeon dissects back the flaps as far as the joint line with the aid of forceps

The wrist and finger being fully extended the operator once more takes hold of the digit and proceeds to open the joint from the palmar aspect He cuts the glenoid ligament transversely against the base of the phalanx, divides the lateral ligaments and finally completes the operation by cutting the extensor tendon Disarticulation may be effected from the dorsum but it renders the section of the glenoid ligament a little less easy

The synovial sheath for the flexor tendons may be closed

The glenoid ligament remains in the stump The two palmar digital arteries will require to be ligatured or twisted

The cicatrix is vertical, i e in the long axis of the limb

2 Operations for the forefinger —In order that the cicatrix may not be exposed to pressure when the thumb is opposed to the stump or when anything is being held in the hand the following modified procedures should be carried out —

1 By the racket incision with the vertical cut placed upon the side of the index nearest to the middle finger and with the incision carried a little farther on the radial

Disarticulation of Fingers at the Metacarpo Phalangeal Joints

The following methods will be described

1 By oval method
2 Operations for the forefinger
3 Operations for the little finger

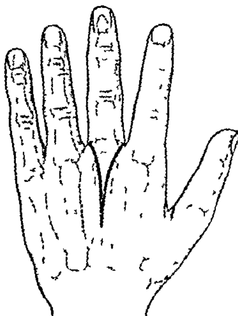


Fig 52 —Amputation through meta carpo phalangeal joint by posterior racket shaped incision

1 By the oval or racket method —The dorsal incision is commenced just above the middle of the metacarpal bone and is carried down in the median line of the finger until it has passed the base of the head of the metacarpal bone

The cut now divides and its limbs sweep obliquely across each side of the root of the finger They are joined on the palmar aspect by a transverse incision which exactly follows the crease between the finger and the palm and is therefore level with the free margin of the web (Fig 52)

The surgeon having made out the position of the joint holds the finger in the prone position in his left hand An assistant steadies the hand and keeps the other fingers out of the way Throughout the whole operation the limb is kept in the prone position The knife is entered upon the

dorsum, and is carried first across one side of the root of the finger and then across the other side The incision is completed by the transverse palmar cut Three separate cuts with the knife are therefore required The incision should at first involve the skin only

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The assistant now takes the finger while the surgeon dissects back the flaps, as far as the joint line with the aid of forceps

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The synovial sheath for the flexor tendons may be closed

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DISARTICULATION OF FINGERS AT THE METACARPO PHALANGEAL JOINTS

The following methods will be described

1 By oval method
2 Operations for the forefinger
3 Operations for the little finger

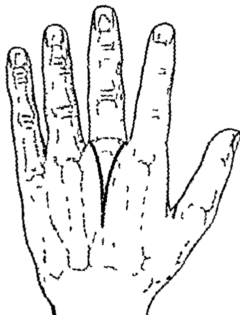


FIG 52 —Amputation through meta carpo phalangeal joint by posterior racket shaped incision

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1 By the racket incision with the vertical cut placed upon the side of the index nearest to the middle finger and with the incision carried a little farther on the radial

than on the ulnar side of the digit In the latter situation it corresponds to the web

ii By unequal lateral flaps the external flap being the larger of the two

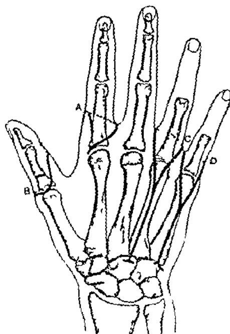


Fig 53

A Disart ulati[illegible] [illegible] flap B [illegible] flap C disarti[illegible] with its met[illegible] [illegible] D [illegible] little finger

iii By the externo palmar flap of Farabeuf The incision commences at the joint line just to the radial side of the extensor tendon It is carried down along the outer side of the dorsum nearly as far as the centre of the shaft of the phalanx It is then made to sweep across the palmar aspect of the finger to the web From the web it passes by the shortest route to the point at which the incision commenced (Fig 53 A)

The flap is dissected up carrying with it all the soft parts down to the bone The tendons are divided and disarticulation is effected in the usual way

This (Farabeuf s) method should be employed whenever there is sufficient sound tissue on the radial side of the digit available

3 Operations for the little finger —These have for their object the removal of the cicatrix from an exposed position

i By a racket incision with the vertical cut placed upon the side of the digit nearest to the ring finger and with the incision carried a little farther on the ulnar than on the radial side of the finger

ii By unequal lateral flaps the internal being the larger

iii By the interno palmar flap of Farabeuf It corresponds to the flap already described as employed for the index finger with the necessary difference that the position of the incisions is transposed This is the method of choice

Comment.—Surgeons are divided in opinion as to the desirability of removing the head of the metacarpal in cases of amputation of the fingers If the head is removed when the scar is healed the loss of the finger is almost unnoticeable In fact patients will state that only when they buy gloves do they miss the finger Against this procedure it is argued that removal of the head of the metacarpal weakens the transverse arch of the palm by dividing the transverse metacarpal ligament In women and wherever an æsthetic result is required the head should be removed In working men the head should be left especially in the case of the third and fourth digits the conspicuous prominence being unimportant in these cases

Amputations and Disarticulations of the Thumb

In performing an operation through the first or the second phalanx or in disarticulating at the interphalangeal joint one or other of the methods already described may be employed

The two most suitable operations are the following —

1 **By the racket incision** —The incision commences upon the dorsum opposite the neck of the metacarpal bone and is continued down along the line of the extensor tendon until the base of the first phalanx is passed Here the incision divides to form the oval the palmar cut crossing the thumb transversely about opposite to the centre of the shaft of the phalanx

The steps of the operation have been already described p 118) Disarticulation may be effected from the dorsum

The two extensor tendons are divided opposite to the

joint line The flexor longus pollicis tendon may be severed opposite to the palmar incision, and the extremity of the tendon may be attached to the sesamoid bones The latter structures should be carefully detached from the base of the phalanx and are left in the stump

The sheath for the long flexor tendon should be closed Two or more digital vessels will probably require ligatures

3 **By oblique palmar flap** —This is Farabeuf's method It is most excellent in cases where the tissues permit of so large a flap being cut

The dorsal incision is U shaped the concavity being towards the nail and the bend of the U opposite to the joint line

The palmar incision also is U shaped the convexity being towards the nail and the bend reaching nearly to the inter phalangeal crease in the skin

The lines of the cut follow the lateral borders of the thumb (Fig 52 B) The flap is dissected up in the usual way The extensor tendons are divided opposite to the joint and the long flexor about the middle of the phalanx The operation is finished in the manner already described

Comment —As already noted it is important to retain as long a stump in the thumb as possible since in the use of the hand it almost equals in value the other four digits together Hence after machinery accidents etc, it is often better to trim up the available tissues left than to follow the orthodox methods of amputation given above

CHAPTER III

AMPUTATION OF THE FINGERS AND THUMB WITH PORTIONS OF THE METACARPUS

Instruments —A stout narrow scalpel with a blade about 1½ inches long, a fine keyhole saw small retractors bone cutting forceps, a rugine if the periosteum is to be preserved dissecting and artery forceps scissors needles etc

Position —The surgeon sits with the patient s hand before him The limb should be in the position of prona tion The operator grasps the finger to be removed keeping his hand supine An assistant placed opposite to the surgeon, holds the patient s hand in the required position and keeps the sound digits out of the way

The following procedures will be described —

1 Partial amputations
2 Disarticulation of a finger with its metacarpal bone
3 Disarticulation of the thumb with its metacarpal bone

1 **Partial amputations.**—As much of the meta carpus should be preserved as is possible In such partial operations the deep palmar arch is not exposed to the risl of being wounded the attachments of certain tendons are preserved and the carpo metacarpal synovial sacs may not be opened up

The racket method should be employed The vertical incision follows the median dorsal line of the metacarpal while the oval cut traverses the web and follows the trans verse digito palmar crease

The general features of the operation are the same as in the complete disarticulations (*see* below)

The dorsal incision should be commenced a little way above the point at which it is intended to divide the bone

The bone should be severed with a fine saw whenever possible the soft parts being protected by a director during the passage of the instrument The shaft is apt to be much crushed if bone forceps are employed

The second and fifth metacarpals should be divided obliquely so that the end of the bone may not project unduly upon the margin of the hand

2 Disarticulation of a finger with the corresponding metacarpal bone —The racket incision is conveniently employed The operation may be illustrated upon the *ring finger* (Fig 53 c) The joint line having been made out the handle of the racket is commenced just above the articulation and is carried down along the dorsum of the metacarpal until the base of the knuckle is reached

The incision here divides and the oval wound following the clefts between the fingers crosses the web and terminates transversely at the digito palmar crease in the skin

The incision involves at first the skin only the surgeon holding the finger and manipulating it as required with his left hand An assistant now takes charge of the finger while the surgeon deepens the dorsal incision and divides the extensor tendons just beyond the base of the bone

The sides of the shaft of the metacarpal are now bared from one end to the other the knife being kept very close to the bone During this step the surgeon uses his left finger to assist in the separation of the interossei from the shaft the assistant rotating the digit as required

The knife is carried back between the bases of the meta carpal bones (on either side of the bone to be removed) so as to divide the interosseous ligaments the skin is at the same time retracted so as to expose the part To reach the articulation more conveniently a transverse cut may be made at the end of the vertical incision (Fig 53 c)

The operator now carries the knife forwards through the

tissues of the web on either side of the finger and the digit being fully extended, the palmar incision is carried down to the flexor tendons 1 The assistant then holds the finger in the position of extremest extension, while the surgeon lays bare the under surface of the flexor tendons, which he ultimately divides opposite the neck of the shaft 2 While the finger is still extended to the utmost, the operator exposes the palmar surface of the bone as well and as far back as is possible The ligaments of the joint having been divided, the finger is turned back upon the dorsum of the hand and the last structures divided are such resisting palmar structures as still remain together with the tendon of the extensor carpi radialis brevior The digital arteries are divided in the tissues of the web

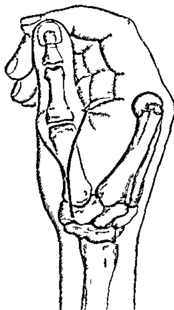


Fig 54 —Disarticulation of the thumb with its metacarpal bone by a racket incision

The synovial sheath of the flexor tendons may be closed with fine catgut sutures if considered desirable

In the case of the *index finger* the vertical incision should be carried along the dorsum of the bone rather than along its radial side as sometimes advised A transverse cut should be made over the trapezoid at the end of this incision

In removing the *little finger* with its metacarpal bone the dorsal incision should be placed rather towards the inner side of the shaft of the bone and from its extremity a short transverse cut may be made towards the ulnar margin of the hand (Fig 53 D)

3 **Disarticulation of the thumb with its metacarpal bone**.—This operation will be but seldom required and when it cannot be avoided every possible portion of bone should be spared. Formal amputation will be best performed by a racket incision of which the vertical limb is dorsal (Fig. 54).

CHAPTER IV

DISARTICULATION AT THE WRIST

Instruments—A narrow amputating knife with a stout handle and a blade from 3 to 4 inches in length, a scalpel dissecting and artery forceps scissors needles etc

Position — The surgeon sits facing the patient's fore arm which is abducted horizontally and with the hand pronated An assistant stands facing the operator and with his back to the patient's shoulder He steadies the limb draws up the soft parts and takes charge of the flaps as they are formed He can also manipulate the hand if required A tourniquet is applied round the forearm

The best method when skin is available is to amputate by a single palmar flap

Operation by long palmar flap—The flap is U shaped It commences half an inch below the radial styloid process and ends half an inch below the tip of the corresponding process of the ulna The outer limb is directed towards the gap between the index and middle fingers the inner limb towards the web between the little and ring fingers

The almost transverse extremity of the flap reaches nearly to the middle of the metacarpus Its general outline is shown in Fig 55 The dorsal incision is carried straight across the back of the limb from one extremity of the palmar flap to the other It will therefore cross the carpus

A stout knife with a blade some 3 inches in length is required

The operator grasps the patient's hand and holds it in the position of extension and supination

Entering the knife half an inch below the styloid process to his left he carries it across the palm in the direction

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The styloid processes of the radius and ulna should be clipped off with bone forceps The flap should be sutured with interrupted sutures a drainage tube being inserted for 24 hours

The palmar flap should never be cut by transfixion The bony prominences in the palm render such a method difficult, and an unduly scanty flap is apt to result

Hæmorrhage—The vessels are divided as previously described The deep palmar arch and the transverse part of the superficial arch are removed with the hand

Comment—The pisiform bone is retained to avoid injury to the ulnar artery The elbow is fixed on an angular splint, the forearm being supinated This operation is rarely performed to-day and its place is taken by an amputation through the forearm giving 7 inches of ulna measured from the tip of the olecranon The amputation is however, a useful examination exercise

indicated to the corresponding point on the other side of the hand, and thus marks out the palmar flap

An assistant now takes the hand and retains it in the same position while the operator proceeds to dissect up the great flap This should not include any remnants of the thenar or hypo thenar muscles

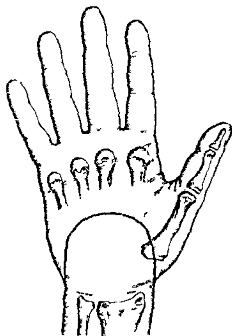


Fig 55 —Disarticulation at the wrist by long palmar flap

The flap should be dissected up to the level of the radio carpal joint care being taken to include the pisiform bone

The surgeon now takes the hand and holds it in the pro nated position while the assistant draws up the skin on the back of the limb The dorsal incision is made The integu ments are dissected up to the joint line and the extensor tendons and the liga ments of the wrist are divided with clean cuts of the scalpel

Nothing now con nects the disarticu lated hand with the forearm but the mass of the flexor tendons and the tissues about them

These are drawn upon and divided by a vigorous trans verse cut made from above downwards—i e from dorsum to palm—care being taken that the palmar flap is held well out of the way at the time

Amputation immediately below the elbow-joint.— No amputation of the forearm should be performed which leaves less than 2 inches of ulna because an artificial limb cannot be fitted to such a short stump Even when 3 inches of ulna is left it is difficult to fit an artificial limb but the amputation is a useful one (Fig 56) The operation is carried out by equal antero posterior flaps



Fig 56 —Amputation through the forearm 3 inches below the elbow by equal lateral flaps with circular division of muscles

Hæmorrhage—The radial artery will run the whole length of the anterior flap, and be cut near its outer border on the inner side of the brachio radialis The radial nerve (ramus superficialis) accompanies it The ulnar artery will be cut shorter and will be in front of the bone and between the flexor sublimis and flexor profundus digitorum The two intero eous vessels especially the anterior may al o need ligature

The more conspicuous nerves form good guides to the divided vessels

CHAPTER V

AMPUTATION OF THE FOREARM

Instruments —An amputating knife with a blade 4 to 5 inches in length a stout scalpel an amputating saw retractors (the gauze or linen retractor used to protect the soft parts during the sawing of the bones may have three tails the middle and narrowest slip being passed through the inter osseous space) pressure and dissecting forceps scissors, needles etc

Position —The arm is abducted and the surgeon stands to the right of the limb in all cases—i e to the outer side of the right forearm and the inner side of the left

One assistant—to the operator s left—steadies the upper arm and retracts the flaps etc The other—to the operator s right—manipulates the forearm and hand and attends to the hæmostasis etc

Operation by equal antero-posterior flaps — The ideal length for a below elbow stump is 7 inches of ulna measured from the tip of the olecranon The semilunar flaps which only contain skin and fascia are marked out and reflected The muscles are divided circularly just beyond the level of the base of the flaps They retract upwards slightly and the periosteum is then stripped up and the bones cut across at the level of the base of the flaps The vessels are tied and the median ulnar radial and interosseous nerves ligatured and shortened The flexor and extensor muscles are sutured across the ends of the bones with a few catgut sutures and the skin sutured with drainage

In an amputation below the middle of the forearm care should be taken to remove any periosteum which might lie across between the bones and to fix the stump until it is completely healed upon a splint in a supinated position The object of this is to guard against fusion of the ends of the bones which would abolish pronation and supination

out the bone for several inches and sawing it through above

Position.—The patient lies upon the back and near to one or other edge of the table according to the side of the amputation The limb is horizontal and is abducted until it is at right angles to the body The surgeon stands to the outer side of the right arm and the inner side of the left One assistant holds the hand and forearm, and manipulates the limb A second stands above the surgeon and attends to the retraction of the divided parts A third assistant commands the main artery

The following two methods will be described The first named is considered to apply especially to the lower half of the arm the second to the middle of the limb —

1 The circular method
2 By antero posterior flaps

1 **Circular method** (*lower half of the limb*) —Fixing the arm with his left hand the surgeon makes a circular sweep through the skin To effect this he passes his hand beneath the limb and bending his wrist over the patient's arm, commences his incision with the heel of the knife upon the surface of the limb nearest to himself, i e upon the outer surface of the right arm and the inner surface of the left

The assistant holding the forearm so rotates the limb as to make the tissues meet the knife

The further steps of the operation have been indicated on pp 107-9

Hæmorrhage —The vessels are divided upon the face of the stump—the brachial to the inner side with the median nerve the profunda brachii artery upon the postero external aspect of the bone with the musculo spiral nerve the superior ulnar collateral artery to the inner side of the brachial with the ulnar nerve In addition to these three vessels several muscular branches will need to be secured

The main nerve trunks should each be sought, drawn down, and divided higher up

CHAPTER VI

AMPUTATION OF THE ARM (THROUGH THE HUMERUS)

EVEN a short stump of the arm is preferable to amputation at the shoulder joint if possible at least one third of the humerus should be left

Eight inches of humerus is the ideal length for an above elbow amputation

Note that two bad results sometimes follow amputation through the arm although the operation may have been skilfully carried out (1) neuritis spreading to the brachial plexus and (2) development of a conical stump

1 Painful scars neuromata, neuralgia of the stump and true neuritis were frequently seen after amputation of forearm or arm during and after the 1914–18 war To avoid such complications sedulous care should be taken to obtain aseptic healing and in the operation *all* the accessible nerves should be truncated so that their ends are buried in the muscles The risk of the terminal scar adhering to a nerve and also to the bone end, is certainly greater after amputation by the circular than by the flap method

2 To prevent conicity in the stump it is obviously best to cover the bone end well with soft parts Here again the flap method has the advantage But if the amputation is done in a boy it is impossible to prevent the chance of the humeral stump steadily pushing down the scar since growth at the upper epiphysial line is not arrested before the age of about 20 This result is not inevitable but conical stump due to overgrowth of the bone is more often seen in the humerus than anywhere else and sometimes takes on fantastic proportions The treatment consists in dissecting

The flaps so cut are cut without precision, and the muscles and skin are divided at the same level

The rapidity with which the operation may be performed is its sole recommendation

Hæmorrhage—Some muscular arteries are divided in the anterior flap In the posterior flap the brachial the profunda brachii and the superior ulnar collateral are found severed These vessels and the main veins should be ligatured before the tourniquet is removed

The nerve trunks ulnar median and radial, should be cut across high up and any others if they can be found

2 **By antero posterior flaps** (*middle of the limb*) —The base of each flap should be equal to one half the circumference of the limb

The combined length of the flaps should equal the antero posterior diameter of the limb

Both are U shaped and the incisions defining them are commenced just below the future saw line

These incisions are so disposed that the brachial artery comes in the posterior flap and great care must be taken that the division between the flaps is not just over the vessel which would in such case probably be split in cutting the flaps by transfixion

An assistant grasping the limb by the elbow and wrist flexes the forearm and rotates the extremity as required

In marking out the anterior flap the arm is so rotated that the flexed forearm is carried towards the surgeon The in*cision is commenced on the side of the arm farthest from the* operator i e on the ulnar side of the right arm and the radial side of the left

The knife is carried from above downwards As it sweeps across the front of the limb to form the tip or bend of the U the arm is held straight and as the blade is carried upwards to complete the other limb of the U the arm is so rotated that the forearm is carried away from the surgeon

The posterior flap is marked out with the knife in the same way the arm *being* lifted up so that the surgeon can see the posterior surface

These incisions concern the skin only

The skin having been evenly freed all round the anterior flap *is shaped out the muscles being divided* obliquely The short posterior flap may be cut by transfixion

The bone having been freed up to the saw *line* the flaps well drawn up and the periosteum stripped up for half an inch above the point of bone section the humerus is divided care being taken of the musculo spiral nerve

The objections which have been urged against the cutting of the whole flap (muscles and skin) by transfixion apply with especial force to this part

required for amputations If the operation is done for tuberculous disease, gouges and chisels, a stout Volkmann's scoop, etc may be required

Position.—The patient lies close to the edge of the table, with the shoulders raised and the head turned to the opposite side The upper limb is carried a little from the side

The surgeon should stand to the outer side of the limb in the case of both the right and the left arm It is often however, more convenient to stand to the inner side of the left extremity Three assistants are required One stands above the operator, by the patient's head, and leaning over the shoulder, retracts the flaps and compresses the axillary vessels before they are divided A second assistant standing below the surgeon by the patient's hip, holds the limb, and manipulates it as required

The third attends to the sponging He is placed either facing the surgeon and upon the other side of the table or by the shoulder

The best method of disarticulation at the shoulder joint is by the **racket method** often called Spence's, after the distinguished Edinburgh surgeon who first fully described it



Fig 57.—Disarticulation at the shoulder by racket incision

(Spence's operation)

The steps are as follows (the right arm is supposed to be dealt with) (*see* Fig 57)

1 The arm is abducted and, if possible rotated outwards A vertical incision through the skin and fascia only is made commencing slightly outside the coracoid process (or below the acromio clavicular joint) Passing down the anterior border of the deltoid to the level of the anterior axillary fold it then curves outwards across the lower part of the deltoid round the arm at the level of the posterior axillary fold across the axilla and back with a slight curve *upwards to join the original vertical incision* Any bleeding

CHAPTER VII

DISARTICULATION AT THE SHOULDER

Methods of controlling hæmorrhage during the operation—1 The method of controlling bleeding by means of an elastic band which is carried across the axilla and brought well up over the point of the shoulder must be condemned as useless and dangerous In such a method the axillary *artery is compressed mainly against the humerus* At the moment of the disarticulation the band is apt to slip It is in the way of the operator and cannot with any ingenuity *be made trustworthy*

2 The compression of the subclavian artery in the neck against the first rib is a more certain mode of controlling bleeding

The vessel is compressed with the fingers or with an instrument shaped like the handle of a door key but even with a skilled and careful assistant the method is not absolutely trustworthy The fingers are apt to slip during the movements of the limb or of the patient and the assistant who controls the artery is somewhat in the way

The methods that are the most valuable are the two next described

3 The main artery may be compressed in the flap by the fingers of an assistant who takes hold of the part immediately before the vessel is divided

4 The artery may be exposed and ligatured before it is divided and early in the course of the operation Although not generally done this preliminary ligature might form one step of Spence's operation as was originally proposed by this surgeon

Instruments—A stout knife with a blade 4 to 5 inches in length retractors and all the usual instruments

may be divided or notched just where it comes off from the axillary Should this happen not only is the nutrition of the deltoid endangered, but considerable trouble may occur in tying the vessel

All the soft parts on the axillary aspect are divided with one sweep of the knife, which is made to emerge from the skin wound already marked out Of course the axillary vessels are divided *below* the point at which they were tied The operation is completed by cutting the axillary nerves short and by uniting the wound so as to form a vertical cicatrix Any remains of the synovial membrane should be dissected out, otherwise they may cause persistent secretion in the living subject A drainage tube should always be inserted at the lower and back part of the wound

If the amputation is done for tuberculous disease of the shoulder joint, it is necessary to cut gouge, or scrape away all diseased tissues, including the glenoid cavity

Comment—The vertical part of the incision (the handle of the racket) is the same as for excision of the humeral head The method therefore, enables the operator (e g in a case of joint disease) to explore the joint through the vertical incision alone If he decides that the arm must be sacrificed he goes on to complete the racket

Hæmorrhage—Unless full precautions are taken this may be very serious As described the axillary vessels are ligatured early before they are divided this is the best way and it obviates any need for compression of the subclavian above But many operators do not employ preliminary ligation they leave to the last the main vessels to be divided and before this is done the assistant compresses them between his fingers, which grasp the inner part of the flap If efficient pressure be maintained on the subclavian this method may prove satisfactory Of course the vessels are secured by ligature directly the amputation is completed The level at which the knife is made to sweep round the arm has been given as about the deltoid insertion In case it is not practicable to obtain so long a flap as this a good result may be obtained with a considerably shorter one

vessels are secured with Wells's *forceps*, and the vertical incision is deepened so as to expose and divide the pectoralis major tendon at its insertion

2 Retract the inner side of the wound tie the axillary artery and veins Deepen the incision on the outer aspect, dividing the deltoid at the level of the slightly retracted skin With the left hand the muscle is raised as the knife divides it below and the flap is reflected from the head and tuberosities of the humerus

3 The tendinous insertions of the capsular muscles, the long head of the biceps and the capsule are now divided by *cutting directly on to the tuberosities and head of the* bone The outer flap is well retracted and the joint capsule is cut transversely with the same sweep of the knife that severs the insertion of the short rotator and elevator mu cles into the tuberosities To effect this the operator holds the knife with the blade directed vertically over the articular surface while the assistant rotates the arm and presses the humerus upwards Thus with the arm fully turned inwards the operator divides in *succession* the *teres minor, infra* spinatus, supraspinatus and finally the subscapularis as the assistant steadily rotates the arm outwards This manœuvre is *one of the most difficult parts of the operation to perform* neatly It will be remembered that these muscles blend with the capsule and the incision through them is made parallel but internal to the margin of the articular surface

4 The arm abducted and rotated out is thrust upwards by an assistant until the head of the bone is projecting well above the glenoid cavity The surgeon taking hold of the head thus made prominent draws it away from the trunk, while he passes his knife behind it so as to cut the posterior part of the capsule and the short head of the biceps the coraco brachialis teres major lati imus dorsi and the long *head of* the triceps which connect the arm to the trunk

In clearing the tissues from the surgical neck of the humerus the operator should keep the edge of his knife close to the bone with *particular care of* the posterior cir cumflex artery Unless that is done this important vessel

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2 **The deltoid-flap method** —A few words will suffice for this In front the incision corresponded to the racket one but behind the *joint it ran not transversely* but right up to the spine of the scapula The large flap including practically the whole of the deltoid was rapidly raised and held by an assistant the rest of the operation with slight modification as to the skin incision was the same as in Spence s method

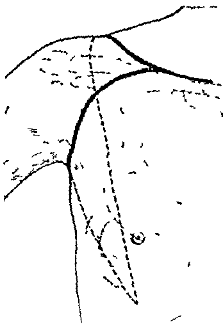


Fig 58 —**Lines of incision in cutting flaps for interscapulo thoracic amputation**

The posterior circum flex artery and nerve were *divided before* they reach the deltoid muscle—a great draw back

The wound and sub sequent scar *must be* much larger than by *the racket method* the only possible advantage being rapidity in dis articulation

Interscapulo-thoracic amputation (Berger's operation) —This am putation consists in the removal of the whole of the upper limb together with the scapula it is *performed in cases of* malignant disease of the upper end of the humerus involving the shoulder joint

Operation —The patient should be placed near the edge of the table so that the shoulder overhangs the head being turned to the opposite side The incision *commences* just external to the sterno clavicular joint and is continued along *the inner* two thirds of the clavicle (Fig 58)

The clavicle is exposed and cut through by means of a *Gigli s* saw at the junction of its inner and outer two thirds Traction

is exerted on the outer portion of the clavicle and the subclavius muscle stripped from its under surface

The first part of the axillary artery and the brachial plexus are now exposed The artery and the vein are divided between ligatures All the main trunks of the brachial plexus are injected with 2 per cent novocain before they are divided this greatly diminishes the shock, and should always be performed The scapular arteries arising from the thyroid axis namely the supra scapular (A. transversa scapulæ) and posterior scapular should be ligatured as they pass in o the posterior triangle of the neck

The anterior flap is fashioned by carrying the incision from the clavicle opposite the coracoid process downwards across the axilla to the inferior angle of the scapula The axilla is thus exposed and its contents stripped downwards The arm is adducted across the chest and the posterior incision mapped out it extends from the outer end of the clavicle downwards to the inferior angle of the scapula where it meets the anterior incision The vertebral border of the scapula is exposed by traction on the posterior flap The following muscles require to be cut through before the limb is removed namely trapezius levator anguli scapulæ rhomboids serratus magnus and latissimus dorsi A drainage tube should be inserted and the wound closed by interrupted sutures

CHAPTER VIII

AMPUTATION OF THE TOES

In dealing with the anterior part of the foot it must be re membered that the foot rests upon the heel the head of the metatarsal bones and the outer margin of the sole In amputation therefore every care should be taken to save as much as possible of the metatarsus and especially of the first metatarsal bone and the phalanges of the great toe The same care need not be taken to preserve every possible part of the four outer toes A sloughing stump has often resulted from too great anxiety to preserve these almost useless digits

The mechanics of the foot are important There is con siderable mobility in the ankle and subastragaloid joints but little in the tarsal joints As a weight bearing mechanism the foot depends on the os calcis the first and other metatarsals for its stability and weight bearing These factors play an important part in the selection of sites for amputations

Instruments —Stout narrow scalpels with blades from 1 to 2 inches in length and with well rounded points a fine keyhole saw or small Butcher s saw bone forceps, dis secting and artery forceps tapes or strips of aseptic gauze to retract the toes scissors needles etc

Preparation of the foot —In the living subject the most sedulous care should be taken to get the parts aseptic before any of these operations for deep seated suppuration in the foot has often followed amputation of a toe After thorough mechanical cleansing of the foot each interdigital cleft in particular should be treated by sponging with biniodide of mercury (1 in 500) or carbolic acid (1 in 20) solution in alcohol Finally just before the operation the parts are painted with iodine in rectified spirit (10 gr to the ounce)

Position —In all these operations upon the toes the patient should lie on the back and the foot be brought well beyond the end of the couch The surgeon should sit at the end of the table facing the patient The assistants stand—

facing the surgeon—one on each side of the end of the table One should fix the limb and hold the toe while the other attends to the wound

A AMPUTATION OR DISARTICULATION OF THE DISTAL PHALANGES OF THE TOES

1 **Disarticulation of the last phalanx of the great toe** *Large plantar flap*—Hold the toe between the thumb and first two fingers of the left hand—the thumb on the pulp of the toe, the fingers on the nail Cut the plantar flap as the toe is thus held Enter the knife—at right angles to the surface—just over the head of the first or proximal phalanx Cut along the side of the toe to the pulp This incision should be parallel to the phalanx and nearer to the dorsal than the plantar aspect Shape the flap as shown (Fig 59) and return to the same point on the opposite side The incision should extend down to the bone

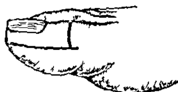


Fig 59.—Disarticulation of the last phalanx of the great toe by a large plantar flap

Let the assistant forcibly extend the last phalanx while the flap is dissected back, it being held by the left hand while so doing In making this flap the surgeon must keep as close as possible to the bone When the glenoid ligament is reached, cut it transversely against the base of the last phalanx The joint is thus opened

Now let the surgeon forcibly flex the toe and make across the dorsum a transverse cut that at once divides the extensor tendon and opens the joint Rotate the toe out and carefully divide the internal lateral ligament Rotate it in, and divide the external band and the disarticulation is complete In disarticulating keep the knife very close to the bone, so as to avoid wounding the plantar digital arteries Cut the lateral ligaments from without inwards The cicatrix of the stump will come well on the dorsum

The long plantar flap should not be cut by transfixion By so doing the vessels are needlessly damaged and the flap is apt to be scanty If on the other hand too large a flap be cut a pocket is made in which effusions may collect

Hæmorrhage.—The two dorsal digital arteries will be cut at the corners of the dorsal incision. They are small and usually do not need to be secured If the flap has been well cut the two plantar digital arteries will not be wounded but will be buried in the flap until they anastomose at its free end They may readily be cut if in dissecting the flap back the knife is not kept close to the bone They also lie near to the sides of the joint (plantar aspect) and may be easily wounded in careless disarticulation.

2 **Amputation or disarticulation of the phalanges of the four outer toes.**—In operating upon the smaller toes the neighbouring digits should be held aside by the assistant by means of sterilized tapes. It is well not to use too long a scalpel

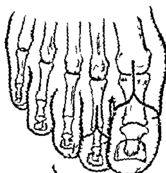


Fig 60

A Disarticulation [illegible] the [illegible] phalanx of a toe by th[illegible] [illegible]ket or oval incision B [illegible] of the great toe by th[illegible] [illegible] oval incision

The second toe should never be amputated unless absolutely necessary Its removal leads to hallux valgus Where its removal is essential special cleft socks should be worn afterwards to try to prevent hallux valgus

The *terminal phalanges* may be removed by the operation just described.

In *disarticulation of the second phalanx* use the oval or racket incision (Fig 60 A) and proceed precisely as in the corresponding operation in the hand (see p 118)

Hæmorrhage — Two dorsal and two plantar digital arteries are found cut in the lateral edges of the wound The dorsal will require no attention the plantar may be twisted.

In *amputation through the first phalanx* employ the circular method. Make a circular cut round the phalanx at the level of the web cut to the bone As the knife crosses the dorsum, flex the toe

so as to cut the extensor tendon short. As the scalpel crosses the plantar aspect extend the digit to its utmost. Separate the soft parts from the phalanx as high up as possible and divide the bone Close the sheath of the flexor tendon (p 119) The vessels are cut as in the last instance. The cicatrix should be vertical i e. dorso plantar Amputation through the first phalanx may also be effected by two lateral flaps of equal size cut by transfixion with a narrow bistoury

Comment—In disarticulating the second phalanx remove the head of the first phalanx, or replace the operation by an ampu tation through the latter bone at the level of the web The head of the first phalanx is large and is apt to play the part of a foreign body between the other toes when it is left. Its removal is no detriment to the use of the foot.

The bone should be divided by a very fine saw rather than crushed by forceps. These operations—partial amputation of a toe—are rarely indicated or performed It is better as a rule to remove the toe at the metatarso phalangeal joint

3 Radical removal of nail bed (Edmund's Operation)—This is done in cases of onychogryphosis ingrowing toe nails and subungual exostosis The plantar flap is turned up as previously described but the dorsal incision is made one third of an inch proximal to the base of the nail and joins the plantar incision about a quarter of an inch from its commencement The nail bed is about ⅛ inch thick and is adherent to the underlying bone It is dissected up and removed the end of the terminal phalanx being sawn off and the flaps sewn up in an H shaped manner (Fig 61) The operation may also be done with nicety through a hexagonal shaped incision It must be remembered that the nail bed projects some ¼ inch proximal to the nail fold in the great toe and that there are large lateral projections at its base

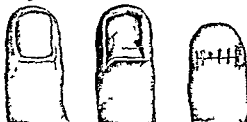


Fig 61—Showing stages in the operation for radical removal of the nail bed

B Disarticulation at the Metatarso Phalangeal Joints

1 Disarticulation of the great toe—In this operation notice must be taken of the very large size of the

head of the metatarsal bone Its dimensions are increased by the presence of the sesamoid bones which should never be removed with the phalanx It is of considerable importance to the future use of the foot that the head of the metatarsal bone should be preserved and it will be seen that the chief difficulty of the operation is to provide flap enough to cover the projection. *It is important also that the scar should be away from the plantar surface* and the line of the sesamoid bones

The joint can be readily made out by manipulation especially on the inner aspect of the foot It is placed about an inch behind the web The projection of the sesamoids can also very easily be defined

1 *By internal plantar flap (Farabeuf)* —The surgeon sits to the front and the inner side of the foot The four surfaces of the digit—dorsal plantar internal and external—should be noted and conceived to be all of equal extent The joint line is made out and, the toe being grasped with the left hand the knife is entered over that line and at a point where the dorsal and internal surfaces meet An incision 2 cm in length is made along the toe *parallel* to the extensor tendon *and on the line between the two* surfaces named It is then curved downwards over the inner surface to the plantar margin (Fig 62) The toe is now turned in and the knife placed beneath the *member is drawn* across the plantar surface to the edge of the web between the toes The knife is next held above the toe and the incision completed by a cut to *the* point of starting made by the shortest route The whole of this incision should involve the skin only



Fig 62 —Disarticulation of the great toe by internal plantar flap

It should now be deepened down to the bone in the same order In drawing the knife across the plantar surface extend

the toe so as to cut the flexor tendon high up Dissect back the flap, keeping close to the bone In the dissection the assistant holds the toe and turns it to one or other side as required while the surgeon uses his left fingers to turn back the soft parts Separate the tissues about the point of starting clear the soft parts from the surface of the joint Forcibly extend the toe and cut the glenoid ligament transversely close to the base of the phalanx The joint is thus opened the ligament with the sesamoid bones remains behind Divide the lateral ligaments and finally cut the extensor tendon Close the fibrous sheath of the flexor tendon by two fine catgut sutures

Hæmorrhage—The outer plantar digital artery will be found cut close to the web, the inner vessel at the free end of the inner flap The dorsal digital vessels will probably not need to be secured

ii *By racket or oval incision*—The toe is grasped by the left hand The knife is entered about 1 cm above the metatarso phalangeal joint in the dorsal median line It is continued down to the centre of the first phalanx, and when carried round the toe to form the racket should just avoid the web (Fig 60 B) The proceeding is identical with that described in disarticulation of the second phalanx (p 144) The joint should be opened from below, through the glenoid ligament

2 **Disarticulation of the outer toes at the metatarso-phalangeal joints**—The best operation is that by the *oval or racket incision* Fig 60 B p 144 illustrates this as applied to the great toe and except in the case of the fifth (where the outer side of the flap should be made the longest as in Fig 61 but of course reversed), the details are exactly the same Note that the metatarso phalangeal joint will be found farther back than would be anticipated and that the dis articulation may be easily blundered over The toe should be well depressed and pulled upon the operator feels for the interval with the point of a narrow bladed scalpel Once the joint is opened the blade is kept close to the bone, while the operator twists the phalanx round

CHAPTER IX

MAJOR AMPUTATIONS IN THE LOWER EXTREMITY

AMPUTATIONS in the lower extremity have of recent years become standardized and simplified This is due to the fact that the surgeon of to day works in closer co operation with the instrument maker Many amputations which were surgically sound have been abandoned because the instrument maker cannot satisfactorily fit an appliance Amputations may now be listed as follows

A **Amputations of general application in modern surgery**
   1 Syme s amputation
   2 Amputation of the leg at the ' new ' site of election
   3 Amputation of the femur in the lower one third

B **Amputations occasionally performed**
   1 Farabeuf s amputation i e amputation at the old site of election
   2 Amputations in the upper part of the thigh

C **Amputations abandoned in modern practice**
   1 *Because surgically unsound*

i Hey s amputation	(Foot became plantar flexed)
ii Lisfranc s amputation iii Chopart s amputation	(Foot became plantar flexed)
iv Teale s amputation v Stephen Smith s disarticulation	(Skin flaps poorly nourished Sores readily occurred)

2 *Because of difficulty in fitting a good prosthesis*

i Pirogoff's amputation	Insufficient clearance for boot heel
ii Stokes Gritti amputation iii Carden's amputation iv Lister's amputation	Too near knee to allow a movable joint on any appliance

It is proposed to describe the first four operations in some detail The three standardized operations have survived the others because they give when properly performed soundly healed stumps to which an artificial limb can be fitted which is inconspicuous both in use and at rest Indeed a trained surgeon will have some difficulty in recognizing which is the artificial limb in an otherwise healthy adult with a sound amputation Even with a femoral amputation there should be no limp except on climbing steps when the artificial knee is at great mechanical disadvantage

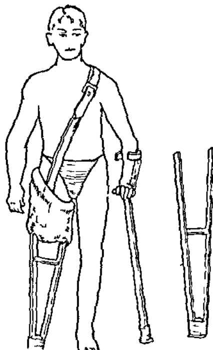


Fig 63 —Pylon leg constructed for the early mobilization of amputations

Some general principles of after-care —The stump is splinted or rested on a pillow immediately following the operation The drains are removed in 48 hours unless there is special indication for prolonged drainage As soon

as the incisions are healed exercises and massage are commenced It is important to avoid an adherent scar Firm bandages are applied to the stump from *above downwards* in order to secure that great desideratum—a cone shaped stump which will readily slide into its socket The limb will not be ready for its prosthesis until all shrinkage has ceased—some six months or more In the interval a pylon leg should be supplied Many instrument makers prefer to supply their own and include them in the cost of the final limb but they can readily be made from plaster of Paris and an old French pattern crutch (Fig 63) During the period of wearing the pylon leg, the patient must exercise all his joints freely An elastic exerciser, modified from the Sandow pattern is very helpful for this

CHAPTER X

AMPUTATION OF THE FOOT

DISARTICULATION AT THE ANKLE (SYME'S AMPUTATION)

THIS is the principal operation for removing the entire foot The flap is made from the heel the soft parts having been peeled off the os calcis (calcaneus) The two malleoli, together with the articular surface of the tibia are sawn off

Historical note —Syme who was Professor of Surgery at Edinburgh and father in law of Lord Lister devised the classical and sound amputation for tuberculous disease of the tarsus—a condition for which it is very seldom performed in these days The anomaly is due to the fact that tuberculous disease is much earlier diagnosed and sinuses are not common

The *blood supply* of the heel flap is a matter of great importance the two chief vessels of supply are the external calcaneal (rami calcanei laterales) of the posterior peroneal (A malleolaris posterior lateralis) on the outer side and the internal calcaneal of the external plantar on the inner side The first named vessel is a continuation of the posterior peroneal It runs just behind the inferior tibio fibular joint and then behind the outer malleolus to the heel With regard to the internal calcaneal artery the posterior tibial divides on a level with a line drawn from the point of the internal malleolus to the centre of the convexity of the heel This line is dangerously close to the line of the incision The internal calcaneal artery arises from the external plantar close to the bifurcation and under the fibres of origin of the abductor pollicis Inasmuch as this is the chief vessel of the flap the greatest care must be taken of it (*see* p 156)

Minute branches may reach the flap from the internal malleolar of the posterior tibial and from the outer and inner malleolar of the anterior tibial

Instruments —A Syme's ankle knife (Fig 64) a scalpel a saw two metal retractors to hold back the flaps when sawing the leg bones lion forceps pressure forceps, artery and dissecting forceps scissors etc

Position —The patient lies on the back with the foot projecting beyond the end of the table and the toes pointing upwards The surgeon sits *facing the end of the table* The lower end of the leg is raised on some firm support to the level of the surgeon s face The surgeon sits to cut the heel flap and stands to cut the dorsal flap and to disarticulate Two assistants stand facing the surgeon, one on each side of the end of the table One steadies the *foot the other attends to the wound*



Fig 64.—Syme s ankle knife

Operation.—An assistant steadies the leg with one hand and holds the foot—by the toes —*rigidly at a right angle to the leg* with the other hand

1 *Heel flap* —The incision starts from the tip of the outer malleolus and in a line nearer to its posterior than its anterior border

It is carried vertically down the heel exactly at right angles to the long axis of the foot runs transversely across the sole and passing up vertically on the inner side of the heel ends at a point about half an inch below the tip of the inner malleolus (Fig 65 A)

In making this incision supposing the right foot to be operated on the surgeon holds the ankle with the palm of his left hand on the dorsum of the foot his thumb being on the outer malleolus and his forefinger on the inner malleolus

Entering the knife at the inner starting point he carries the incision down to the sole and then across the plantar aspect of the *os calcis at one cut* The knife is now re entered at the outer starting point and is carried down to meet the first incision at the sole If *an attempt be made* to perform the incision at one cut and to make the outer limb of the incision by cutting from the heel towards the leg the knife may slip and cut too far up into the leg

running by the starting point On the left foot the same precaution is observed, but the incision is commenced on the outer side

This incision should be carried well and cleanly down to the bone The heel flap is now dissected back the thumb-

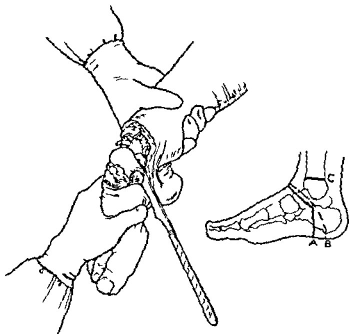


Fig 65 —Syme s amputation disarticulation of the ankle before dissection of the heel flap

A The classical incision B the more modern elliptical incision C the level at which tibia and fibula are sawn

nail of the left hand is used with force to drag back the soft parts while the knife is kept well on to the bone and parallel to the surface of the flap The os calcis must be laid perfectly bare The great point in Syme s amputation is to keep close to the bone

The flap must be cleared from the tuberosities of the os calcis, and then from its posterior surface

This is the classical method as described by Syme Most surgeons now prefer to disarticulate the ankle first, and dissect out the heel flap afterwards in the latter case working of course from above downwards and not in the original manner from below upwards

ii *Dorsal incision* —The surgeon now holds the foot in the left hand in the position of full extension and connects the extremities of the heel incision by a cut which simply sweeps across the front of the ankle region The dorsal and the heel incisions are about at right angles to one another The cut includes all the soft parts down to the bone The tendons must be cleanly divided while the foot is kept on the stretch

iii *Disarticulation* —The ankle joint is at once exposed the anterior ligament having been severed The knife is now introduced into the joint and the lateral ligaments are divided in both instances by cutting from within outwards These complex ligaments are difficult to cut if attacked from the outer side of the articulation The posterior ligament is cut, the upper surface of the os calcis is cleared and by the division of the tendo Achillis the disarticulation is completed

iv *Removal of the malleoli* —The soft parts are cleared from the two malleoli and the lower end of the tibia great care being taken not to damage the flap The exposed bones are then divided by a horizontal saw cut the saw being applied about a quarter of an inch above the inferior margin of the tibia

The flaps may be protected by spatulæ during the sawing If it should be necessary the malleoli may be held with lion forceps

Before the wound is adjusted by sutures a hole may be made in the centre of the heel flap and a drainage tube introduced

Hæmorrhage —The anterior tibial artery is cut in the dorsal flap just opposite the centre of the front of the ankle The external and internal plantar arteries are divided in the inner section of the heel flap The two vessels are close together The following vessels may give rise to hæmorrhage the internal malleolar of the posterior tibial behind the

inner malleolus the anterior peroneal (ramus perforans) in front of the tibio fibular joint the external and internal malleolar of the anterior tibial in front of their correspond

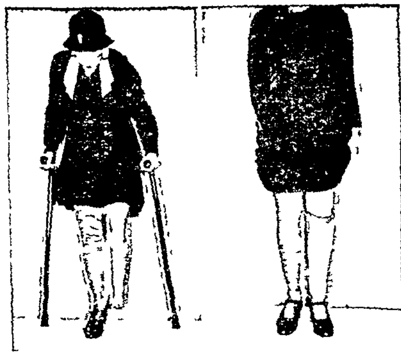


Fig 66 —Modified Syme's amputation

Contrast the neat contour of the stump and the extra clearance between the end bearing and the ground with Fig 67 The light metal limb fitted although slightly wider than the natural ankle is quite neat

(*By courtesy of Mr F R Desoutter*)

ing malleoli The internal saphenous vein is cut in the dorsal flap the external in the heel flap

Comment—The amputation gives admirable results and secures a sound and firm stump The patient walks upon the natural tissues of the heel The tendo Achillis forms an attachment with the mass of the cicatrix With

a properly adapted boot a patient after Syme's amputation can walk with little appreciable lameness

The following special points in the operation must be noted —

1 It is important that the flap should be accurately cut

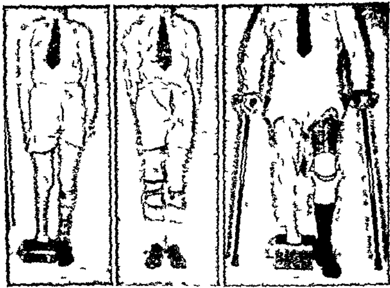


Fig 67.—Syme's amputation

Note the great increase in terminal circumference of this stump The heel pad is likely to loosen and become painful The light metal limb fitted to this case is necessarily very much wider than the natural ankle

Fig 68—Syme's amputation on a bow legged patient

This shows clearly the difficulty of constructing an artificial limb with correct alignment

(*By courtesy of Mr E F Desoutter*)

In some text books it is advised that the incision be carried from the tip of the outer malleolus to a point half an inch *behind* and below the inner malleolus If this be done, there is great probability that the posterior tibial artery will be divided before its bifurcation and the main artery of the flap (the internal calcaneal of the lateral plantar) be thus lost

If the flap be too large there is great difficulty in dissecting it back and it will probably be dangerously scored and bruised in the attempt

ii In clearing the os calcis the periosteum may be at the same time peeled off—as many advise—and so made to form an important constituent of the heel-flap In young subjects (those under the age of 14 years) the posterior epiphysis of the os calcis may be detached and left undisturbed in the flap it generally comes away during the process of clearing the os calcis In still younger patients —say those under 10—the superficial parts of the os calcis will be found imperfectly ossified and chunks of the soft bone may be cut away in a too vigorous clearing of the heel flap

iii It is desirable that all the articular surface of the tibia should be removed and as the under surface of the bone is much domed the section must be made as high up as a quarter of an inch so as quite to clear the summit of the concavity In young patients the whole of the lower epiphysis may be removed by a too liberal use of the saw the measurement (a quarter of an inch) refers to adults

The only objection to Syme s operation is the bulky heel flap and the attendant difficulty in dissecting out the os calcis to obviate this a shorter heel flap may be cut starting three quarters of an inch in front of the point of the heel and carried upwards skirting the tip of the external malleolus and curving just above the ankle joint to the tip of the internal malleolus (Fig 65 B)

The incision is prolonged straight across the sole of the foot to meet the incision on the outer side, the foot being held strictly at right angles to the leg This is known as the *Modified Syme s*

CHAPTER XI

AMPUTATION OF THE LEG

THE stump left by an amputation through the leg carries weight from the lower border of the patella and the upper border of the tibia upon the upper part of the bucket of the artificial limb The length of the stump is useful up to a point from a leverage point of view but more than 9 inches is cumbersome since the ankle mechanisms would abut on to it The artificial limb would have to be made thicker on its lower part and symmetry be neglected Moreover the circulation of the lower part of the leg is poor so any amputation below the middle third should not be considered

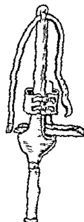


Fig 69 — Farabeuf s peg leg, designed for use after the old site of election amputation

Perkins and his co workers at Roehampton consider that the ideal length for a below knee operation is 5¼ inches of tibia measured from the joint line Nothing is gained and much is lost by having a longer stump while the instrument maker will have difficulty with shorter stumps This difficulty will progressively increase until all the usefulness of the knee is lost if the bones are less than 2 inches long *It must be remembered however that all measurements given for length of stumps are for patients of average height and must be modified for variations of stature*

The new site of election —This term is applied to such amputations giving some 6 inches of tibia The term new ' is inserted to differentiate it from the older Farabeuf s opera

tion where the patient walked with a bent knee—the sailor s peg leg (Fig 69) There can be no comparison between the functional and æsthetic results of the two operations

Operation of amputation at the new site of election *Flaps*—Hooded flaps i e flaps in which the incision commences below the line of proposed bone section are preferable The flaps may be antero posterior, equilateral

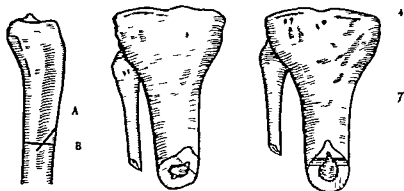


Fig 70—Method of sawing the tibia **Fig 71.—Method of sawing the bones of the leg** **Fig 72—Method of sawing the bones of the leg**

long posterior or indeed of any variety except lateral The surgeon has often to cut the skin as best he may in cases of accidents with skin lacerations etc The best flaps are probably antero internal and postero external

The bones—The manner in which the bones are sawn is of some importance, especially as the prominent anterior border of the tibia is apt to project into the anterior wound when the flaps have been adjusted The remarks now to be made apply to all amputations in this region

The interosseous membrane having been incised the periosteum covering the tibia is divided by a circular cut This circular cut is joined from above by two lateral vertical incisions through the investing membrane The two flaps—

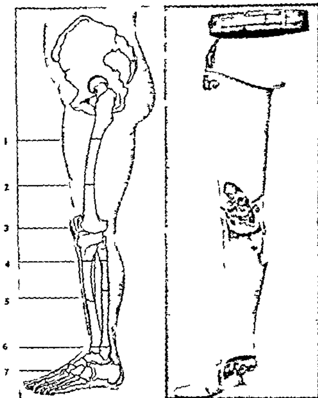


Fig 73 —Amputation sites of the lower extremity

An artificial leg (*Desoutter*) is shown for comparison demonstratin« in section the space required for the knee and ankle mechanism

1 Minimum of 3 to 4 inches f femur valuable f r above knee type limb *but every inch f bone abov this very valuable for through hip type* 2 stump of 9 to 11 in hes m *asured from the p rineum* is the most satisfactor; 3 amputat or s at r immediately above knee undesirable for prosthesis 4 tibia 2 in he l n« tl e minimum « hich can be used for below knee type limb—in th s case the fibula must of course be of equal length 5 t b a 6 inches long with fibula 1 inch sl orter gives best results in belov knee *cases* ſ modified Symes—very sati factory in selected cases 7 all pa tial f ot amputations undesirable for prosthesis The sites of amputation indicated in the diagram are necessarily only approximate

anterior and posterior—of periosteum thus marked out should be separated from the bone by an elevator If preferred, these flaps may be dissected up from the bone with the deepest layers of muscle or on the other hand the periosteum on the posterior surface of the tibia may be ignored, and only the anterior segment preserved Some surgeons strip up the periosteum from the fibula also

The periosteum is retracted to a point just above the saw line The surgeon stands in the same position—i e to the outer side of the right leg and to the inner side of the left —and divides the fibula first to prevent inadvertent fracture of this bone if the tibia is divided first The limb is still so placed that the external surface is uppermost In sawing the left fibula, the point of the saw is directed downwards towards the floor In dividing the right bone the point of the instrument is directed upwards towards the ceiling The fibula should be divided about 1 cm above the tibia and the saw should pass obliquely from above downwards and inwards (Fig 70) The saw is now entered upon the inner surface of the tibia above the level at which the bone is to be divided The instrument is made to cut downwards and outwards for a certain distance (Fig 70, A) The transverse saw cut is then made from before backwards (Fig 70 B), with the result that the whole bone is divided the piece marked out by the first saw incision drops off and the tibia presents a sloping surface on its inner side

The periosteal flap or flaps having been adjusted over the divided bone and any deep sutures having been inserted the operation is completed by closing the surface wound

CHAPTER XII

AMPUTATION OF THE THIGH

THE operations so named concern amputation through the shaft of the femur and occupy an intermediate position be tween disarticulation at the hip on the one hand and the supra or trans-condyloid operations on the other For the most part they involve a division of the bone below its centre 10 to 12 inches of femur measured from the top of the great trochanter must be looked upon as the ideal stump

Owing to the difference of attachment of the muscles on front and back of thigh the hamstrings after division contract much more than the quadriceps hence after ampu tation through the thigh the scar tends naturally to be drawn to the back of the limb If flaps are employed—and this is certainly the best way if sufficient tissue can be obtained for them—the longest flap must of necessity be shaped from the front Hence also the ordinary method of circular amputation is not advisable through the thigh except in cases of arterial disease when the shortest skin flaps are desired (e g senile gangrene) If it is done a very oblique incision, higher in front than behind is made, as shown in Fig 75, A To make retraction of the sleeve of skin and fascia more easy two lateral vertical cuts may be added This and other points are described in the introductory chapter (*see* p 105) The method of choice is however that by shaped anterior and posterior flaps

Before describing this it is necessary to consider an im portant point the relation of the femoral vessels to the flaps On this will depend the exact incision to be made at different levels of the thigh In an amputation by antero posterior flaps made above the middle of the thigh the femoral artery together with the profunda will be found in the anterior

flap In a like amputation performed below the middle of the limb the main artery will be divided in the posterior flap In

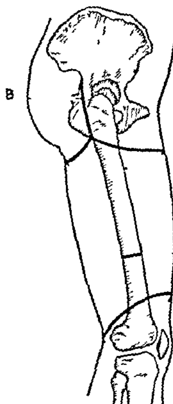


Fig 74

A Circular amputation of thigh *a* saw line of same B disarticulation at the hip by external racket incision

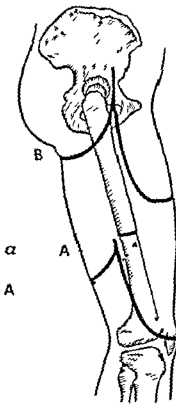


Fig 75

A Amputation of the thigh by long anterior and short posterior flap (the anterior flap is here shown unusually long) B disarticulation at the hip by antero-posterior flaps

this position however there is risk of splitting the artery if the anterior flap much exceeds in width one half of the circumference of the limb This is avoided by placing this flap a little

towards the external aspect of the limb instead of fashioning it in the median segment When the amputation is carried out in the middle of the thigh, the anterior flap should be antero external This will bring the artery into the posterior flap

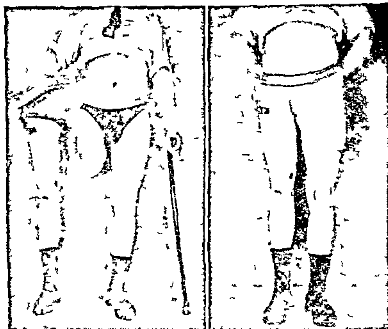


Fig 76 —Above knee amputation of ideal length and contour

Note the taper shape of the stump which is so valuable for the fitting and control of the artificial limb also that the light metal artificial limb is suspended by a pelvic band only with no chest or shoulder harness

(By courtesy of Mr F R Desoutter)

There will be room enough in these operations for the application of an elastic tourniquet round the upper part of the thigh, held up towards the groin by another rubber band passed under it Shock from loss of blood is to be guarded

against in two ways—first by emptying the limb by elevating it vertically before the tourniquet is applied and secondly by intravenous injection of saline solution

Amputation by long anterior and short posterior flaps—It is assumed that the femur is to be divided about its centre The two flaps are U shaped The anterior flap is equal in length to two thirds the diameter in width to the diameter of the limb at the point of section The posterior flap has the length of one half the diameter of the extremity at the same level The anterior flap is the wider its base slightly exceeding half the circumference of the limb (Fig 75 A)

Operation—i The limb is rotated outwards on the right side and inwards on the left The anterior flap is marked out first In the right thigh the surgeon commences with the inner limb of the flap cutting downwards He then carries the knife across the front of the extremity and finishes with the outer limb of the flap the leg being now rotated inwards In dealing with the left limb the conditions are reversed and the cut is first made upon the external aspect The incision includes the integuments only

In marking out the posterior flap the surgeon s hand is beneath the thigh and the knife being entered at the farther limb of the anterior flap is drawn across the posterior surface and towards the operator This cut also involves the integuments only

The limb is again suitably rotated as the knife passes along its course

ii The tissues of the anterior flap are now pinched up with the left hand and the muscles contained therein are divided obliquely from without inwards—i e from the skin to the bone The soft parts are so cut that the flap is thinnest at its extremity and thickest at its base At the latter site it will include the whole thickness of the muscular mass in front of the femur The tissues are divided obliquely (the edge of the knife being turned towards the bone at the base of the flap) in distinction from the transverse division of parts which obtains in the circular amputations

The muscles of the posterior flap may be conveniently cut

by transfixion. They may however, be divided in the same way as are those of the anterior flap Transfixion is better suited for muscular limbs

The muscles are divided well down to the bone at the bases of the flaps The femur is bared by further retraction of the soft parts and is sawn across at right angles to its axis Sufficient muscular tissue should be retained to suture over the bone

The descending branch of the external circumflex artery will always be found divided in the anterior flap together with many muscular branches In the lower third of the limb the supreme geniculate will be divided about the inner part of the hinder flap

In the angle between the flaps and in the muscular tissue close to the bone branches of the perforating arteries will be found cut

It is needless to say that the muscular arteries in the thigh are large and numerous and that the great veins require to be occluded by ligature Drainage should be provided for and the stump should be placed between sand bags a copious dressing having been firmly secured by bandages

The stump should not be raised on pillows because this will cause a flexion deformity

CHAPTER XIII

DISARTICULATION AT THE HIP

Modes of controlling hæmorrhage during the operation —Various methods have been adopted for preventing excessive hæmorrhage during this disarticulation The chief of them are the following

1 The femoral artery may be ligatured either before the flaps are cut or during the fashioning of the flaps where the incision crosses the line of the artery as in the method known as the anterior racket ' (p 168)

The procedure involves a little time and when a special incision has to be made somewhat complicates the operation The method however has many advantages It has been urged by some surgeons that the artery is apt to be secured unnecessarily high up and that the vitality of the main flap may be in consequence impaired but this objection has not been confirmed by practice

2 The femoral may be compressed in the flap by the fingers of an assistant who grasps the base of the flap just before the vessels are divided

3 *Some surgeons advise digital compression of the femoral* or external iliac This can however hardly be carried out except in a child The fingers are very apt to slip during the manipulation of the limb

4 A strong rubber tourniquet may be applied round the limb it should lie parallel with and as near as possible to Poupart s ligament being held up by a second rubber band inserted under it A thick pad of gauze will be found useful placed between the femoral vessels and the tourniquet This method is quite practicable especially in amputation by the external racket incision but it must be admitted that *the tourniquet is apt to get in the operator s way*

In all these methods it is needless to say that the securing of the femoral does not affect hæmorrhage from the branches of the internal iliac artery

5 To prevent hæmorrhage from branches of both external and internal iliac arteries during the operation Sir William Macewen strongly recommended manual pressure on the aorta

The assistant who does this should stand on a stool placed on the left side of the patient by crossing his right leg over the left one he throws the weight of his body on to his doubled up right hand which is made to compress the aorta at the level of the umbilicus The pressure which can be maintained during a long operation without undue fatigue need only be sufficient to stop the femoral pulsation tested by the assistant s left hand

6 Several other methods to prevent bleeding have been used from time to time One we have used with success is that of clamping the common iliac artery This vessel is reached above Poupart s ligament either by the intraperitoneal or the extraperitoneal route When the artery is reached it should be grasped between the blades of a short intestinal clamp with just sufficient pressure to stop the pulse below but not enough to damage the coats of the vessel At the end of the amputation the clamp is of course removed and the abdominal wound carefully sewn up

I **Disarticulation through an anterior racket incision** —This method is also known as the anterior oval method

Position —The body is drawn down until the pelvis rests upon the extreme lower edge of the table The sound limb is secured out of the way Some care has to be taken to prevent the patient from slipping entirely off the table The surgeon stands at the outer side of the thigh in the case of both the right and the left extremity and faces the patient

Operation —1 No tourniquet is applied The incision is commenced at the centre of Poupart s ligament and is carried downwards along the course of the femoral vessels for about 3 inches It is then made to curve inwards so as to cross the adductors about 4 inches below the genito-crural fold The knife then sweeps over the posterior aspect of the thigh crosses the outer side of the limb a little way below the base of the great trochanter and is carried obliquely across the anterior aspect of the thigh to meet the vertical incision

about 2 inches below its point of commencement (Fig 77) This incision concerns at first only the skin and the sub cutaneous tissue It cannot be made with one sweep of the knife and the limb must be so rotated as to make the tissues meet the knife

ii The femoral sheath is now exposed at the upper part of the incision and the vessels are laid bare by dissection The common femoral artery is ligatured in two places close together and is divided between the liga tures The femoral vein is secured in the same manner and then cut across at the same level as the artery This (the safe division of both main artery and vein between the ligatures) is the most critical and difficult part of the operation The greatest care should be taken in its performance

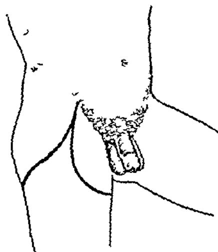


Fig 77 —Disarticulation at the hip by an anterior racket incision

iii The skin is freed round the whole length of the incision, and is allowed to retract a little The integuments however are not especially dissected up

iv The stout scalpel is now taken and is carried through the muscles in the outer flap In this way are divided the sartorius the rectus and the tensor vaginæ femoris

Carry the knife backwards rotate the limb in and divide the insertion of the gluteus maximus Rotate the limb out and divide the psoas muscle

v The muscles in the inner flap are now cut at the level of the retracted skin These include the pectineus the gracilis and the superficial adductors

vi Adduct the thigh and rotate it inwards so as to expose

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aspect of the limb are divided with one sweep of the blade at the level of the retracted skin These tissues will include the hamstrings the great sciatic nerve and the undivided parts of the adductors, principally represented by the adductor magnus

The main nerve trunks anterior and posterior, are isolated and shortened an artery requiring ligature may be met in the centre of the sciatic nerve

Control of hæmorrhage—One feature of this operation is the avoidance of serious bleeding by preliminary ligature of the common femoral artery and vein though several vessels divided in the later stages of it come from the internal iliac (especially the obturator gluteal and sciatic) These latter should be looked for before division, and clamped with Spencer Wells s forceps to be tied later An assistant pressing on the aorta at essential moments will help to reduce the total loss of blood to a minimum

It has been already noted that the difficult step may be the satisfactory ligature of the femoral artery and vein before commencing any section of the muscles The difficulty is due to the short length of artery available—one to two inches only, and the proximity of several branches (deep epigastric circumflex iliac, just above the part to be tied, superficial epigastric etc directly from it and the long saphenous vein etc, joining the common femoral)

The mistake is sometimes made of tying the superficial instead of the common femoral artery, whereby the chief vessels to cause trouble escape

Drainage etc of the wound—If the operation is for incurable tuberculous disease the acetabulum is sure to be extensively affected and must be gouged away as far as is safe

In every case a drainage tube will be required and a voluminous dressing securely fastened to the trunk The linear wound is well away from the perineum

During or just after the operation it is well to give saline infusion freely into a vein of the opposite arm Other special precautions to avoid shock immediate and deferred should be taken

Comment—In previous editions amputation by transfixion was fully described, but this method the only merit of

the great trochanter Divide the insertions of the muscle attached to this process notably the gluteus minimus and medius

vii Abduct the limb and rotate it out Incise the cap-

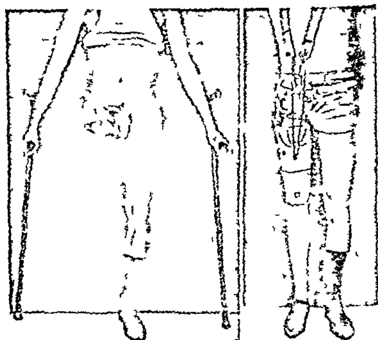


Fig 78 —Amputation of the hip

The shape of the stump sh[ows] clearly the value of saving even 1 or [2] inches of femur The shape of the hip is retained and provides a much better grip for the artificial limb than disarticulation

(By courtesy of Mr L R Doutler)

sule transversely Disarticulate Divide the round ligament and also the obturator externus tendon if it has up to the present escaped division

viii The limb being still more rotated outwards the head of the femur is dragged forwards and the longer knife being passed behind the bone all the soft parts at the posterior

PART IV —OPERATIONS ON THE BONES AND JOINTS

CHAPTER I

OSTEOTOMY

By osteotomy is understood the division of a bone in its continuity for the relief of deformities of various kinds

Linear osteotomy implies the division of the bone in its continuity in a single line usually transverse and made by the subcutaneous method (Fig 79)

Cuneiform osteotomy is the term applied to the cutting out of a wedge shaped piece for the relief of such deformity as that represented by the curved tibia met with in rickets and is always made through an open incision

Osteotomy with resection of part of the shaft of a long bone is done occasionally to bring two unequal bones approximately to the same length, or for removal of a myeloma

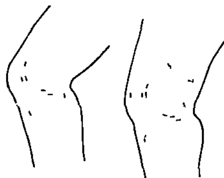


Fig 79 —Linear osteotomy performed for flexion contracture at the knee

Instruments employed —The following are the instruments required in these operations an ordinary scalpel chisels and osteotomes of various sizes mallet sand bag or large lead or wooden block blunt hooks

which was the rapidity with which it could be performed by expert hands has been practically abandoned It had amongst other drawbacks the grave one that the inner end of the large wound was situated close to the perineum and hence *infection was difficult to avoid* Moreover *extreme* economy in time of an operation has ceased to be required if better results can be obtained by slower methods In amputation at the *hip joint now become a rare operation* the choice lies between the method by external racket incision and that by anterior racket with preliminary ligature of the main vessels

The *mallet* should be made of metal (lead) throughout for purposes of sterilization The heavier the head the better

The *sand bag* or *sand pillow* is used for the purpose of fixing or embedding the limb during the process of dividing the bone with the osteotome

A block of metal such as a leaden weight with rectangular sides will be found very useful instead of the sand bag It should be encased in a sterilized towel and when placed transversely it forms a good fulcrum on which to complete the fracture of the bone after it has been nearly chiselled through

A wooden block shaped like the headsman s instrument also answers well

Linear osteotomy with the osteotome—The limb having been firmly embedded in a sand pillow in a suitable position a simple incision is made down to the bone This cut should be of sufficient size to admit the largest osteotome intended to be used. It should be so placed as to avoid structures of importance should be through the least vascular part of the limb and should reach the bone by the most direct route

Before the knife is withdrawn the osteotome may be introduced by its side the knife acting as a guide

Some surgeons make the skin wound correspond in direction and position with the intended wound in the bone, i e in the transverse axis of the limb It is however best to place the surface incision at right angles to the future bone-cut and turn the osteotome after that instrument has been introduced This incision in the long axis of the limb has the advantage of going between the fibres of any muscle overlying the bone (e g the vastus medialis in osteotomy for genu valgum) Moreover the periosteum will be less damaged by a longitudinal incision

The osteotome is driven through the bone with the mallet cutting in various directions until *the bone is divided* The edge should be directed from any neighbouring great vessels As the cut in the bone becomes deeper finer osteotomes may be used

The *chisel* has the same form as the ordinary carpenter s chisel It is square at the end, and has a very sharp edge It should be made of the finest steel and be very carefully tempered The part of the instrument near the cutting edge is alone raised to a great degree of hardness the rest of the blade is kept softer, so that there shall be no danger of its snapping The edge is bevelled on one side only, according to the ordinary pattern and the thickness of the blade at

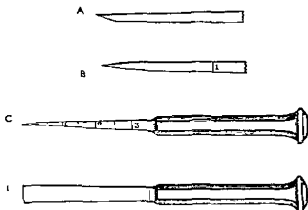


Fig 80 —Section (A) of chisel and (B) of osteotome (*both actual size*) C and D Macewen s osteotome

the base of the bevel is about one twelfth of an inch Chisels with unduly thick blades are clumsy and are apt to splinter the bone

It is desirable that the blade and the handle be made of one piece of metal that the handle be octagonal for convenience of holding and that the head be rounded smooth and projecting to receive the blows of the mallet

Macewen s *osteotome* has a wedge shaped extremity, and has the outline as seen sideways of an attenuated double inclined plane (Fig 80) It is square at the end has a sharp edge, and is tempered in the same way as the chisel Hence it travels when struck along its own length unlike a chisel

mere linear osteotomy leaving a gap between the divided ends when the limb has been adjusted which gap appears to fill up without complication

In the severer kinds of deformity a wedge may be removed much smaller than is necessary entirely to overcome the deviation a gap of moderate size being left when the limb has been brought into its normal position upon a splint

The wedge moreover need not extend through the entire thickness of the bone It may involve possibly three fourths



Fig 81 —Diagram to show the lines of the chisel cuts in cuneiform osteotomy for angular deformity

of the diameter of the bone the remaining fourth being bent or broken.

In performing this operation a chisel will be found to be more convenient than a saw In some forms of bony ankylosis of joints however the saw may prove to be the more suitable instrument or both saw and chisel may be used together A Gigli wire saw may often be convenient

The incision in the soft parts must of necessity be comparatively large—as large, at least, as the base of the intended wedge It need be no larger since the skin can be displaced in one or other direction according to the position of the chisel As soon as the bone is exposed the periosteum must be divided and carefully separated with the elevator

In dividing the bone the chisel should be employed and

The osteotome should be grasped firmly in the left hand, steadied by the inner border resting on the patient's limb The surgeon ought to cut to instead of away from himself thus if he is operating on the inner side of the left limb he ought to stand on the left side of the patient and cut towards himself

In many cases one can divide the bone subperiosteally and this should always be aimed at After the cut in the periosteum has been made a curved elevator is used to detach the membrane on both sides of and behind the bone This being done the elevator is used to steady the bone and to protect the soft parts as the surgeon chisels through towards it This manœuvre is especially useful in dividing the shaft of the tibia close to the back of which the posterior tibial vessels might be endangered by the chisel Of course, the elevator is held by the assistant

It is usual to insert one or two sutures in the skin wound and to put up the limb (without drainage) in plaster of Paris, having obtained a perfect position by manipulation Care should be taken to apply sufficient cotton wool under the plaster case to prevent the latter from unduly constricting the limb

Cuneiform osteotomy —In this form of the operation a cuneiform or wedge shaped piece of bone is removed to remedy an abnormal curve or angular deformity It has been applied in the treatment of the curved femora and tibiæ resulting from rickets in some cases of bony ankylosis at an unusual angle and in a few examples of angular deformity produced by malunion after fracture

The exact size and shape of the wedge must be carefully determined, and must obviously depend upon the position and extent of the deformity

In general terms it may be said that the sides of the wedge should be at right angles to the axis of the bone respectively above and below the seat of the operation (Fig 81) In actual practice however so large a wedge shaped piece of bone is very seldom removed If the curvature in the bone be not extreme many surgeons content themselves with a

mere linear osteotomy leaving a gap between the divided ends when the limb has been adjusted which gap appears to fill up without complication

In the severer kinds of deformity a wedge may be re moved much smaller than is necessary entirely to over come the deviation a gap of moderate size being left when the limb has been brought into its normal position upon a splint

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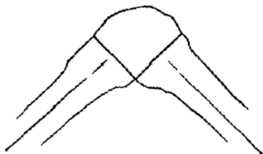


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In dividing the bone the chisel should be employed and

not the osteotome The instrument must be so held that its bevelled edge faces towards the portion to be removed

If a large wedge has to be removed it should be dealt with in sections A small wedge shaped piece should first be taken out and then thin slices of bone should be shaved from each side of the exposed bone until a cuneiform cavity of the desired size and shape has been produced

If an attempt be made to remove a large wedge at once, it will be found that the chisel is apt to go awry to incline towards the straight edge and in consequence an uncertain division of the bony tissue is made

It is not well to attempt to prise out the wedge of bone with the chisel The bone so treated is apt to split or the chisel may be broken The wedge can be removed better with forceps aided by an elevator

After the bone has been dealt with the periosteal flaps and any divided aponeuroses should be brought together by buried sutures

CHAPTER II

OSTEOTOMY FOR FAULTY ANKYLOSIS OF THE HIP JOINT AND OTHER CONDITIONS

This measure is carried out in certain cases of rigid ankylosis of the hip joint resulting from disease in which the limb has assumed a faulty position and all milder methods of treatment have failed In the most usual deformity the thigh is flexed adducted and a little rotated in The object of the operation is to bring the limb straight

Two methods have been described the transcervical osteotomy (Adam s operation) and the subtrochanteric (Gant s operation) The first-named is of classical interest only as the bone section is dangerously near what was an infected area (in tuberculous and old septic arthritis cases) The danger of a flare up of infection is too great and the operation has been abandoned in favour of Gant s subtrochanteric osteotomy

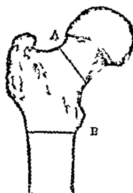


Fig 82 - Osteotomy for faulty ankylosis of the hip

A Intracapsular B extra capsular

Through the shaft of the femur below the trochanters (Gant s operation) —The incision is longitudinal and is placed over the outer aspect of the femur at about the level of the lesser trochanter It crosses the lower insertion of the gluteus maximus and passes through the vastus externus muscle

The osteotome is introduced, and

the bone is divided immediately below the lesser trochanter and in a line at right angles to the shaft of the femur (Fig 82 B) or, as Kocher advocated obliquely downwards, for wards and inwards

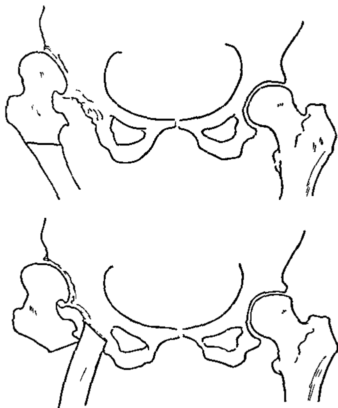


Fig 83 —Lorenz s osteotomy as performed for old congenital dislocation of the hip—its main indication

Comment —In these situations the bone should be divided completely It should not be partially cut through and then fractured lest dangerous splinters of bone be

produced The assistant therefore should be careful how he holds the limb and how he brings pressure to bear upon the parts which are being divided

It must be remembered that the muscles and fasciæ are contracted on the side of flexion, and this may hinder immediate straightening of the limb Immediate straightening moreover is dangerous and may give rise to thrombosis in the femoral vein

Gradual and gentle extension must therefore be carried out

OSTEOTOMY AS A WEIGHT RELIEVING MEASURE AT THE HIP

Osteotomies at the hip are required for other conditions than faulty ankylosis Among these are osteotomy for old unreduced congenital dislocation of the hip and for painful mono articular arthritis These may be summarized as weight relieving osteotomies, the main principle being the redistribution of weight by transference direct to the pelvis Two such operations are often performed the Lorenz osteotomy and the McMurray armchair type of osteotomy

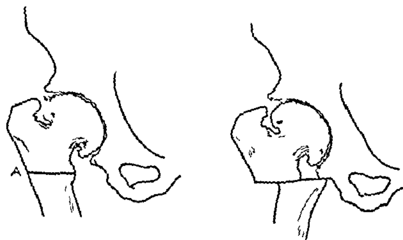


Fig 84 —Simple weight relieving osteotomy as performed for osteo arthritis

Lorenz bifurcation osteotomy —This finds its special indication in old cases of unreduced congenital dislocation of the hip The femur is divided obliquely from below upwards and without inwards (Fig 83) The lower portion is then forcibly abducted and driven into the original acetabulum which it must be remembered will be shallow and small It is important to secure sufficient abduction to give a stable leg The shortening is not great and can be compensated by a high boot

McMurray or armchair osteotomy —This is an operation yielding very satisfactory results in arthritis and in old cases of fracture of the neck of the femur There is no precise anatomical line for the division of the femur which in this case is divided horizontally The level is chosen from the skiagram and is at the level of the *under* lip of the acetabulum This will sometimes be above and at others below the level of the lesser trochanter and no attention is paid to this point The femur is divided and then pushed medially and when the fragments have united an armchair effect is obtained (Fig 84)

CHAPTER III

OSTEOTOMY FOR GENU VALGUM

This is a rare procedure nowadays At the beginning of the century it shared the dubious honour with excision of tuberculous glands of neck of being the commonest operation performed at any children s hospital Rickets of course has become very uncommon

Anatomical points—In the severer forms of genu valgum—and it is in these only that osteotomy is practised—there is a great increase in the size and depth of the internal condyle This is due to an increase in the diaphysis of the bone rather than in the epiphysis (Fig 85)

The epiphysial line is about on a level with the tubercle for the adductor magnus tendon The trochlear surface of the femur belongs to the epiphysis

A transverse section of the femur about the epiphysial line will show that the outer part of the bone is much more extensive than the inner part and this disproportion is continued for some little distance upwards in the less expanded part of the bone (Fig 86) The medullary

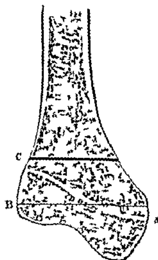


Fig 85 —Vertical section of the lower end of a deformed femur from an extreme case of genu valgum

A Line of epiphysis B transverse line drawn at level of adductor tubercle C line of Macewen s operation

canal ceases some way above the point at which the shaft of the bone widens out to form the condyloid extremity

The femur may be divided either from its outer or its inner aspect Sir William Macewen s method is by making the incision and entering the osteotome on the inner side of the femur thus reducing the risk of injuring either the popliteal artery or the lateral popliteal nerve While many surgeons perform this operation from the outer side we advise that Macewen s precise instructions should be followed exactly

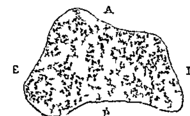


Fig 86.—Transverse section of the femur about the level of the epiphysial line showing the triangular outline of the bone

A P E I Anterior posterior external and internal surfaces

Macewen's supracondyloid operation — The patient lies upon the back, close to the edge of the table Both hip and knee are flexed the thigh is abducted and rests upon its outer side The knee is well fixed upon the sand pillow The surgeon places himself on the outer side of the limb

A sharp pointed scalpel is introduced on the *inside* of the thigh at a point where the two following lines meet—one drawn transversely a fingers breadth above the top of the *external* condyle and *a longitudinal one drawn half an inch in front of the adductor* magnus tendon The scalpel here penetrates at once to the bone and a longitudinal incision (Fig 87 A) is made sufficient to admit the largest osteotome Before withdrawing the scalpel the osteotome is slipped by its side until it reaches the bone

The scalpel being withdrawn the osteotome which was introduced *longitudinally* is now turned transversely *in the direction required for the osseous incision* (*Fig* 87 B)

The osteotome is then driven through the bone across the

front part of it again through the centre and finally across that part behind the central portion Care must be taken that the cutting instrument does not go right through the bone into the soft parts and still more that it does not enter the popliteal space

After a certain amount of the bone has been divided, a finer instrument may replace the one first employed.

It is desirable to complete all the work intended by any one osteotome before removing it from the wound

When the operator thinks that the bone has been sufficiently divided the osteotome is laid aside and a sterilized towel is placed over the wound While the surgeon holds this in place he at the same time employs that hand as a fulcrum with the other he grasps the limb lower down using it as a lever and jerks if the bone be hard or bends slowly if the bone be soft in an inward direction when the bone will snap or bend as the case may be

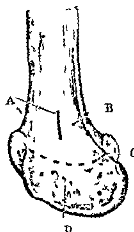


Fig 87 —Macewen s operation for genu valgum

A Skin incision B osteotome incision C epiphysial line D inner condyle

The metal or wooden block may be used as the fulcrum Steady pressure is safer than the jerking movement just described There is usually some hæmorrhage from the wound when the pressure is relaxed, but a dressing firmly applied will always stop it Two or three silk worm gut sutures may be required

Comment —The highest part of the articular surface of the femur is a good guide to the level of the lowest part of the skin incision

The exact level at which the bone is divided may vary to some extent but Macewen s rule cannot be improved upon.

For a short distance above the condyles the femur has

a much thicker outer than inner border in many instances the outer is twice as thick as the inner (*See* Fig 86)

If the form of the bone be not borne in mind the surgeon may think that he has divided it sufficiently and yet he may find that it will not yield, owing in most cases to the posterior and outer part remaining intact

In young subjects up to the age of 15 or 16 the division of the internal two thirds of the bone will usually suffice the remainder being broken but in adults especially when the bone is hard and brittle the section should be more complete and as little fracturing should be attempted as is possible

The cut in the soft parts may be made transversely and be so placed as to correspond to the intended bone incision By this means the osteotome is more readily introduced and more easily re inserted should it be accidentally removed during the operation The transverse incision spares the soft parts a certain amount of bruising and disturbance but it does not favour so complete a subcutaneous method

Although the synovial pouch of the knee joint reaches as high as the level of the bone incision it is not in the way of the actual wound itself since it tapers to the middle line as it ascends A certain amount of fat intervenes between the synovial pouch and the bone and the osteotomy cut is posterior to the pouch

The wound is above the superior medial geniculate artery and below and anterior to the supreme geniculate Bleeding from this vessel has however been reported during the operation The surgical calamity of injury to the popliteal artery has occasionally occurred even to the most experienced operators

If the bone is brittle fracture of the remaining cortex (osteoclasis) may cau longitudinal fissuring as in breaking a piece of firewood To obviate this some surgeons place a few drill holes in the remaining cortex and fracture the bone 7 to 10 days later This has the added advantage that the bone ends are then sticky and the surgeon has more control of the fragments

CHAPTEP IV

GRAFTING WITH BONE OR CARTILAGE, AND OTHER SPECIAL METHODS

The chief purposes for which bone or cartilage grafts are employed are to fill defects in bone, e g removal of a myeloma from a long bone or a cavity left by necrosis or in cases of old ununited fractures In the former group of cases many small grafts may be inserted, in the latter it is essential to fix a single graft of bone firmly joining the two ends of the long bone together

But in all these procedures whether large or small grafts are used and whether bone or cartilage is employed, the following rules hold good

1 Perfect asepsis must be secured and the grafts must be entirely covered in i e the operation wound should be closed without drainage
2 Grafts from lower animals are of little or no value Many centres now possess bone banks where sterile non diseased human bone can be stored in deep freeze The fact that such grafts are not autogenous does not matter since all grafts disappear in time and merely provide a framework for new bone to be laid down

Cartilage Grafting

Grafts of cartilage are more easy to manipulate than those of bone cartilage being a tissue of lower organization than bone they are more certain to take, and they are particu larly useful for repairing gaps in the skull A case might be

taken, for example, in which a considerable portion of the skull vault has been lost and the wound has healed with a depressed scar adherent to the dura

The scalp around the scar is shaved and treated antiseptically, and the skin over the region of the sixth seventh and eighth ribs is also prepared The scar is excised and the scalp all round freely mobilized so that the edges can later be sewn together without tension The dura mater is separated from the gap in the bone, and if necessary is repaired as far as practicable Moist sterilized gauze is packed into the wound The rib cartilages are now exposed by incision, the muscles and aponeuro es cleared from around them by scalpel and raspatory, and as much of the cartilage cut away as will be requisite to fill the gap It is easy to shape the cartilage so that the pieces fit the cavity exactly after the gauze has been removed

The scalp including the pericranium is now drawn over the grafts and closely sutured with silkworm gut and a moist dressing is bandaged on (the best head bandage is of butter-cloth muslin) Before the small wound on the front of the chest is sutured the aponeuroses should be accurately sutured together over the gap left by the removal of cartilage with catgut or fine silk with this precaution no ill effect need be feared

The cartilage grafts do not diminish in size subsequently and using this method remarkable success has been attained even in replacing the destroyed orbital margin malar bone or part of the lower jaw (Morestin)

Bone Grafting

Grafting with bone is of especial use in operating for ununited fractures of the long bones The grafts should if possible be autogenous (*see* p 187) and are usually sawn and chiselled from the tibia The fibula or one of the ribs may also be utilized for the purpose Certain grafts especially ones for local use are taken from the ilium It is not essential to retain the periosteum but if the graft has periosteum on the surface it will grow better and more surely ' (Hey

Groves 'Modern Methods of Treating Fractures) A high speed electric saw is valuable for cutting grafts as fracture of the graft—a not unknown disaster—may readily occur when a long graft is cut with a chisel It is essential that the graft should be firmly implanted into the bed prepared for it in the bone ends and to secure this fixation is much the most difficult step of the operation It can occasionally be obtained by wedging the graft into the medullary cavities but this has obvious drawbacks in that large or very long grafts cannot be used more often a longitudinal slice is cut out of corresponding surfaces of the two ends of the bone which must also be pared and shaped to fit closely together Before fitting the graft into the surface prepared for it the latter should be scored transaversely with a fine saw so as to provide *furrows between the bed and its graft in which pro callus can* at once collect (Hey Groves)

The best method of securing the graft is by drilling holes and inserting vitallium screws which are completely inert Stainless steel wire and pins are also used Catgut or other soft sutures should never be trusted for the purpose

When the operator is satisfied that the bone graft is well fixed in place he should draw together by sutures the overlying soft tissues so as to avoid leaving any cavity If all bleeding has been stopped by ligatures after the tourni quet is removed the wound should be securely sewn up with out drainage The part is maintained at rest in good position on a splint for as long a time as a simple fracture would take to unite indeed some light fixation apparatus may be neces sary for a good deal longer Any ivory pegs will ultimately be absorbed silver wire can also be left in indefinitely During the after treatment all the joints of the affected limb must be kept mobile and massage should be applied to the muscles

The operation described is often difficult and requires much technical skill and experience Its results are sometimes brilliant but for example in the mid humerus are apt to be wholly disappointing even if the grafting is repeated several times

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After any of these methods of internal fixation the surgeon should splint the limb as carefully as if no peg, plate, etc had been employed

Watson Jones has devised an excellent traction apparatus for the treatment of fractures of the tibia (Fig 88) The apparatus consists of a thigh support clamped on to any table to which is fixed an L shaped traction bar with coarse adjustment and a rotating handle with fine adjustment Length and alignment are secured by the apparatus while the leg hangs in the line of gravity Apposition is maintained by pressure of the operator s hands while a plaster is applied When the plaster is dried the traction pin through the tibia can be withdrawn

The operative treatment of fractures of the patella and olecranon will now be considered

Wiring the transversely fractured patella (Fig 89) —Fracture of the patella is a frequent accident usually the break is transverse with some tearing on either side of the quadriceps aponeurosis and in front of the fracture this aponeurosis nearly always dips down like a curtain over the surface of each fragment If they are pressed together these fibrous curtains will tend to prevent bony union moreover, as shown by X rays the fragments tilt so as to come into apposition only by their under edges (those towards the joint) Unless open operation is done bony union (except in the rare cases of stellate fracture and those of a mere transverse crack without displacement) is exceptional Fibrous union may give a very useful limb but with more or less wasting of the quadriceps and the limb cannot be relied upon in an emergency nor for work involving climbing ladders etc Moreover, the fibrous band between the fragments will probably stretch more and more as years go on

Hence every case of transverse fracture should be wired if the patient is in good condition partly to prevent wasting of the quadriceps partly to restore a useful limb with freely mobile knee joint in a short time

Steps preliminary to the operation —When the bone fractures a good deal of blood is extravasated into the knee joint,

OPERATIONS ON RECENT SIMPLE FRACTURES OF LONG BONES

Simple fractures in long bones are only operated upon when reduction of deformity cannot be obtained by closed methods or when fixation by closed methods is tedious or difficult With improved methods of traction and plaster plintage such operations are less common The site of the *fracture* is exposed and reduction effected under direct visual control The choice of method of fixation then arises

Here no question of bone grafting is involved but only the correction of displacement and mechanical fixation at the

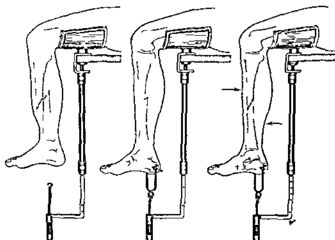


Fig 88 —Watson Jones s tibia traction apparatus for fractures of the tibia

seat of fracture Encircling rings of wire or bands are now obsolete and their place has been taken by vitallium or stainless steel screws Lane s plates and screws still command a wide use although plates and screws made from animal bone also have supporters Ivory pegs are used by some surgeons in preference to steel screws Intramedullary fixation with a long piece of bone or steel pin has its uses

to a pair of wire-cutters (they may be combined in the same instrument)

The patient's limb should be slightly elevated on an inclined plane obtained by raising the lower part of the operating table All but the small area round the patella should be thoroughly enclosed and protected by a moist sterilized sheet A final disinfection of the prepatellar skin is made most operators paint it with weak iodine in spirit (2 per cent) Throughout the operation it is well that the operator's gloved hands alone should touch wound instruments swabs and sutures his responsibility as to asepsis being thereby undivided

An inverted U incision is made to encircle the patella above and at the sides The flap of skin and fat etc is dissected off the front of the patella and held retracted by means of one or two suture retractors The fracture line being exposed the torn aponeurosis which probably dips down and adheres to the bone is lifted up with the raspatory and its frayed edges are cut off At the same time all blood clot in the joint is cleared away with a moist swab With the hand drill four oblique holes are made through the two halves of the patella each pair corresponding in position

The left hand steadies the bone as the drill is made to emerge just short of its cartilaginous margin (joint surface) The two upper or two lower tunnels in the bone are made first the cannula in each case follows the drill and through the cannula the wire is passed and the cannula withdrawn over it The protruding wire is threaded into the cannula in each opposite tunnel and both are withdrawn The manœuvre is more difficult to describe than to carry out The two loops of wire taking a firm hold of each patellar fragment are now tightened up and a longitudinal groove is cut in the aponeurosis for them to rest in As the wires are twisted up and cut short the knee joint should be in full extension The twisted ends are gently pressed and hammered down into the grooves and the aponeurosis can usually be sewn lightly over them The flap is now replaced after securing any bleeding points and the wound sewn up with silkworm gut No drainage is required A moist gauze

and for a few days there is a condition of traumatic inflammation This is treated by rest on a back splint (elevated) and perhaps the application of an ice bag An X ray plate is taken showing the exact size of the fragments a very small lower fragment would indicate deviation from the ordinary method of wiring such as passing the wire round and not through the bone (*see* Variations p 194)

It is essential to get the skin in front of the knee aseptic

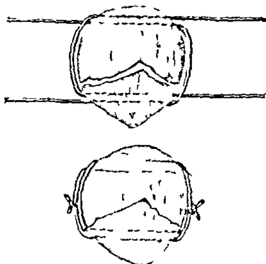


Fig 89 —Wiring patella

it should therefore be prepared thoroughly with ether and soap biniodide of mercury in alcohol etc on three successive days About the fifth day after the accident the patient will be ready for operation

The operation —Stanks s steel wire No 16 gauge is the best material a hand drill should be used for making the holes through the bone and a steel cannula facilitates the introduction of the wire Strong forceps for grasping and drawing through the wire are necessary, in addition

to a pair of wire cutters (they may be combined in the same instrument)

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dressing is bandaged on and the limb kept on a splint for a few days As soon as the wound is healed and the stitches are removed i e from ten to fourteen days the splint is dispensed with and the knee may be bent The patient will be walking about within three weeks of the operation The wire if properly applied and its ends buried seldom gives trouble subsequently or requires to be removed it forms moreover a strong bond of union until new bone is produced As is well known the patella forms callus very slowly

Comment and variations—If carefully carried out, the method gives the most perfect adjustment of the two fragments and is the best for those cases in which they are roughly of equal size i e where the wires can get an oblique and firm hold Moreover two wires placed at a little distance from each other give twice as secure a union as only one But if the lower fragment be too small to give a hold for them it may be better to drill a hole *transversely* through each fragment pass two wires and twist them up on either side of the bone so as to squeeze the fragments together (Variation 1) Some authorities prefer to encircle the patella with a single loop it can rarely be possible to obtain perfect apposition in this way (Variation 2)

There is at the pre ent time considerable discussion as to the best treatment for cases of fractured patella Not all wired cases are satisfactory A rarefying osteitis has followed the use of wire with much arthritis The wire has been known to snap and give rise to delayed re fracture Even late sepsis has occurred with unhappy results in the form of ankylosis

An alternative treatment consists in excision of the patella This is being widely tried It can be emphatically recommended in cases with severe comminution and separation Here wiring is impossible and to leave the irregular fragments alone is to invite arthritis In simple transverse fractures of the patella the results of excision are less certain and the late results are of course not yet available It should be remembered that fracture of the patella is an injury to the extensor apparatus of the knee of which the patella is but a part

It is very important to repair the torn ligamentum patellæ and adjacent fascia in all these injuries

Wiring the fractured olecranon (Fig 90) —This operation is very similar to that employed for fracture of the patella An inverted U shaped incision is the best if the triceps aponeurosis dips down between the fragments it must

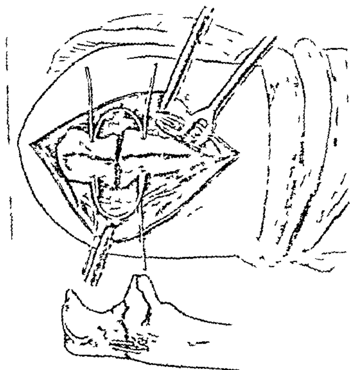


Fig 90.—Fracture of olecranon sutured by two wire loops

be lifted up and trimmed blood clot is removed and holes are drilled transversely through the olecranon process and the ulnar shaft Through these holes two loops of

dressing is bandaged on and the limb kept on a splint for a few days As soon as the wound is healed and the stitches are removed i e from ten to fourteen days the splint is dispensed with and the knee may be bent The patient will be walking about within three weeks of the operation The wire if properly applied and its ends buried seldom gives trouble subsequently or requires to be removed it forms moreover a strong bond of union until new bone is produced As is well known the patella forms callus very slowly

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CHAPTER V

EXCISION OF JOINTS AND BONES

General considerations—By the term excision of a joint is implied the removal of the articular extremities of the bones entering into the formation of the joint, together necessarily with the cartilage and synovial membrane the procedure being carried out with the least possible amount of injury to the surrounding soft parts

This definition while it applies precisely to the usual excisions of the knee and elbow is allowed also to include the usual excisions of the hip and shoulder in which only the articular extremity of the long bone forming the joint is completely removed

Formal excision of a joint may be replaced in suitable cases by what is termed erasion meaning thereby the complete removal of the diseased synovial membrane with perhaps a partial removal of the joint ends of the bone, where diseased by means of gouge or chisel In erasion of a joint it is important to preserve the main ligaments otherwise the limb will be flail like

Special instruments employed — Bone forceps, sequestrum forceps excision knives retractors of various kinds lion forceps periosteal elevators rugines saws of various kinds chisels and mallet bone gouges sharp spoons

General conditions of excision operations.—In performing excision of a joint the following general points are to be observed

1 The whole of the diseased tissue must be removed
2 The amount of the bone removed must be limited by

wire are passed their ends are made to cross each other are drawn taut twisted and cut short The twisted ends are pressed down close to the bone

As an alternative a screw bone peg or steel pin may be driven longitudinally through the olecranon into the shaft of the ulna The fracture must be first reduced so subcutaneous methods are inapplicable

CHAPTER V

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Special instruments employed. — Bone forceps, sequestrum forceps, excision knives, retractors of various kinds, lion forceps, periosteal elevators, rugines, saws of various kinds, chisels and mallet, bone gouges, sharp spoons.

General conditions of excision operations.—In performing excision of a joint, the following general points are to be observed:

1. The whole of the diseased tissue must be removed.
2. The amount of the bone removed must be limited by

such common surgical requirements as are necessary to ensure the prospect of a useful limb

3 The soft parts must be as little disturbed as possible

4 It is *important in young subjects* that the active epiphysis be not destroyed, lest a greatly shortened limb result—a matter of infinite consequence in the lower extremity

5 The bones must be so divided as to be adapted to the purposes of the new articulation, or be favourable for ankylosis in a good position

The periosteum of the bones should be as little disturbed or removed as is practicable but it is rarely advisable *in dealing with cases of tuberculous disease to adopt the elaborate* methods of preserving periosteum that are associated with the name of Professor Ollier

6 The limb must be splinted in a suitable position e g flexion of forearm to a right angle in excision of the elbow

EXCISION OF THE CARPAL SCAPHOID —The removal of the proximal fragment of the carpal scaphoid after fracture gives good results when avascular necrosis is present

The scaphoid is exposed on its dorsal aspect through a short incision on the outer side of the extensor longus pollicis tendon The fractured scaphoid is identified and the dead fragment removed

The wound is closed up by a few interrupted silkworm gut sutures The hand is then put up in plaster in dorsi flexion

EXCISION OF THE CONDYLE OF THE MANDIBLE —This *operation is required in cases of ankylosis of the temporo* mandibular joint The operation is carried out through a curvilinear incision commencing over the middle of the zygoma and passing downwards in front of the tragus In this operation the surgeon is working in a somewhat cramped space with the zygoma above the facial nerve below the parotid gland in front and the external ear behind After the skin and subcutaneous tissues have been incised the small flap is turned upwards A transverse incision is now made at the posterior end of the zygoma opening up the capsule of the joint and the synovial membrane The neck

of the mandible is exposed and a fine Gigli saw is passed round this with a small aneurysm needle The neck of the bone is cut through with this saw and the condyle removed Sometimes the neck of bone may be divided with a small pair of cutting pliers All bleeding from the cut surface of

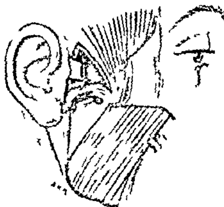


Fig 91 —Drawing showing how a strip of the temporalis muscle may be used to ensure a false joint after excision of the condyle

the bone can be controlled by the firm application of some bone wax to the raw area A piece of fascia lata celluloid or muscle graft (Fig 91) should be inserted between the bony surfaces so as to ensure a false joint and prevent any bony union

The wound is closed with two or three interrupted sutures

CHAPTER VI

EXCISION OF THE ELBOW

This operation consists in the removal of the lower end of the humerus and the upper extremities of the radius and ulna

In civil life the chief indication for its performance is tuberculous disease which has resisted complete rest and other measures It should not however be performed in young children or in the aged

Another and less frequent indication is bony ankylosis of the elbow in a bad position During the War the operation was performed in some cases of compound fracture into the joint etc In these cases it was found very difficult to prevent the new joint becoming rigid

Excision through a posterior median incision —The patient lies upon the back with the body close to the edge of the table The surgeon stands on the side that is to be operated upon An assistant is placed on the opposite side of the table—i e upon the patient s sound side —and holds the limb The upper arm should be vertical or at right angles to the surface of the couch the elbow should be a little flexed and the forearm be carried across the patient s chest so that the elbow projects prominently outwards In dealing with the right joint the operator should stand by the patient s loins and in dealing with the left well to the outer side of the trunk A second assistant standing on the opposite side can help to steady the limb by grasping the arm and forearm as he leans over the body and a third helper placed to the surgeon s left should be prepared to assist in retracting the divided parts

In this attitude it will be understood that the ulna and

olecranon will be uppermost A tourniquet should be applied round the arm if the case is one of tuberculous disease

Narrow bladed rectangular retractors made of the stoutest steel are requisite

1 *The incision*—The skin incision is about 4 inches in length is in the long axis of the forearm and is so placed as to cross the centre of the olecranon fossa of the humerus and the olecranon process and then follow the crest or posterior border of the ulna (Fig 92 A)

The centre of the incision corresponds to the tip or summit of the olecranon The stout short bladed excision knife may be carried at once down to the bones cutting on to the olecranon, bisecting the triceps tendon, opening the articulation through the posterior ligament and reaching the back of the humerus

As the cut will be made from "above downwards' it will be seen that in the position occupied by the limb the knife will cut first upon the ulna which is uppermost and then upon the humerus

2 *Clearing of the olecranon and the condyles of the humerus*—In clearing the bones for excision the following rules should be observed i The surgeon should keep the knife point and edge constantly turned towards the bone and his incisions should be short and made with force ii The rugine and the elevator are used almost as freely as the knife The gloved finger or thumb of the operator s left hand will assist in detaching and retracting the soft parts Good retractors must also be employed at every step The main feature of the operation is the efficient peeling of the olecranon and the irregularly shaped humerus

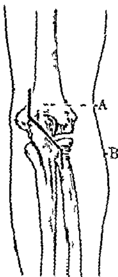


Fig 92 — Excision of the elbow

Median vertical incision (the usual one) B Other a bayonet incision used in cases of ankylosis

The inner part of the wound is first dealt with

CHAPTER VI

EXCISION OF THE ELBOW

This operation consists in the removal of the lower end of the humerus and the upper extremities of the radius and ulna

In civil life the chief indication for its performance is tuberculous disease which has resisted complete rest and other measures It should not however be performed in young children or in the aged

Another and less frequent indication is bony ankylosis of the elbow in a bad position During the War the operation was performed in some cases of compound fracture into the joint etc In these cases it was found very difficult to prevent the new joint becoming rigid

Excision through a posterior median incision —The patient lies upon the back with the body close to the edge of the table The surgeon stands on the side that is to be operated upon An assistant is placed on the opposite side of the table—i e upon the patient s sound side —and holds the limb The upper arm should be vertical or at right angles to the surface of the couch the elbow should be a little flexed and the forearm be carried across the patient s chest so that the elbow projects prominently outwards In dealing with the right joint the operator should stand by the patient s loins and in dealing with the left well to the outer side of the trunk A second assistant standing on the opposite side can help to steady the limb by grasping the arm and forearm as he leans over the body and a third helper placed to the surgeon s left should be prepared to assist in retracting the divided parts

In this attitude it will be understood that the ulna and

olecranon will be uppermost A tourniquet should be applied round the arm if the case is one of tuberculous disease

Narrow bladed rectangular retractors made of the stoutest steel are requisite

1 *The incision*—The skin incision is about 4 inches in length is in the long axis of the forearm, and is so placed as to cross the centre of the olecranon fossa of the humerus and the olecranon process, and then follow the crest or posterior border of the ulna (Fig 92 A)

The centre of the incision corresponds to the tip or summit of the olecranon The stout short bladed excision knife may be carried at once down to the bones cutting on to the olecranon bisecting the triceps tendon opening the articulation through the posterior ligament and reaching the back of the humerus

As the cut will be made from "above downwards' it will be seen that in the position occupied by the limb the knife will cut first upon the ulna which is uppermost, and then upon the humerus

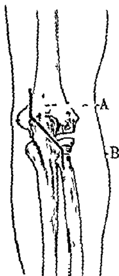


Fig 92 — Excision of the elbow

Median vertical incision (the usual one) B Other s bayonet incision used in cases of ankylosis

2 *Clearing of the olecranon and the condyles of the humerus*—In clearing the bones for excision the following rules should be observed i The surgeon should keep the knife point and edge constantly turned towards the bone and his incisions should be short and made with force ii The rugine and the elevator are used almost as freely as the knife The gloved finger or thumb of the operator s left hand will assist in detaching and retracting the soft parts Good retractors must also be employed at every step The main feature of the operation is the efficient peeling of the olecranon and the irregularly shaped humerus

The inner part of the wound is first dealt with

The inner half of the triceps tendon is peeled from the olecranon with as much periosteum as possible The hollow between the olecranon and the internal epicondyle is now cleared until that process of bone is reached

If the operator keep close to the bones and observe the rules just laid down (p 201) there is no reasonable danger of wounding the ulnar nerve The nerve is readily felt and should be freed so as to be easily retracted beyond the epicondyle with a blunt hook It should not however be really exposed to the eye as its fascial sheath will hide it Of course it is important to use care and gentleness in freeing the nerve from its groove

The surgeon now turns to the outer part of the incision separating the tissues on that side until the outer epicondyle is reached and laid bare In this stage of the operation the outer half of the triceps tendon will be separated and drawn aside without severing its connexion with the deep fascia of the forearm the anconeus will be raised from the ulna the external lateral ligament and the origin of the mass of extensor muscles will be separated from the humerus, and the supinator will be turned well aside Here again strong retractors are of great service It is during this part of the procedure that damage may be done to the posterior interosseous nerve

On both sides of the humerus the muscular origins should not be stripped off the bone higher than is required to clear the latter for the saw It will hardly ever be necessary to divide the bone much above the widest part—i e the level of the epicondyles (Fig 93)

The bones of the joint are now free of one another except upon their anterior aspect

3 *Sawing off the olecranon and the end of the humerus* -- The simplest way is to begin section of the bones with that of the olecranon which is cut through with either chisel or fine saw (or both) The elbow should now be flexed and with a few further touches of knife and elevator in front and at either side of the bone the lower end of the humerus can be made to project into the wound The patient s hand should then be placed in the prone position upon the operating

table In this attitude it can be firmly held, the lower ends of the radius and ulna being fixed rigidly upon the table The assistant who grasps the upper arm should make the lower end of the humerus project, whilst an ivory spatula is held in front of the projecting part to steady it

The surgeon then grasps the bone with lion forceps A narrow saw with a movable back is applied horizontally

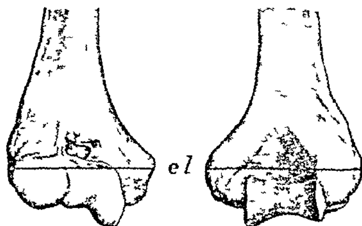


Fig 93 —Front and back views of humerus

The line e l indicates the usual level of the saw cut in excision of the joint The section may require to be made higher up in some cases

to the lower extremity of the bone so fixed and the excision of the humerus is completed

The saw line generally crosses the bone at right angles to its long axis and just below the tips of the epicondyles

While this section is being made the muscles and ulnar nerve etc are carefully held out of the way with curved hooks or retractors The assistant is only too apt to let these slip

4 *Dealing with the radius and ulna and completion of the operation* —The olecranon process has already been removed but it is necessary to examine the cut section of bone and to remove the articular surface of the coronoid process

(a thin section will probably suffice, the insertion of the brachialis anticus should not be damaged)

The head of the radius and superior radio ulnar joint also require attention, but the less bone removed here the better As a rule, the ends of the forearm bones are made to project into the wound and a thin section is taken off both at the same time with a saw

It remains to clear away with the chisel any cartilage left in front of the humerus (*see* Fig 93) and to cut away all tuberculous tissue in the olecranon fossa or elsewhere The tourniquet is removed Some articular arteries are sure to require ligature

The wound is washed out and adjusted with sutures The two edges of the split triceps (especially below) should be drawn together with buried sutures of tendon or catgut It is best to insert a small drainage tube at the inner side through a separate puncture of the skin The limb must be supported with its dressing on a light well fitting splint the elbow being kept flexed the forearm *slightly* pronated and the fingers free

After treatment —After the operation the limb must be placed upon a suitable splint and the bones so adjusted that the greater diameters of the bony surfaces correspond and do not cross The hand should be in the mid position between pronation and supination with the elbow bent to an angle say of 120 One convenient form of splint has a joint opposite the elbow by which the angle can be altered every few days

Gentle passive motion should be commenced as soon as the wound has soundly healed but the support of a specially moulded splint of poroplastic felt will be found advisable for a considerable period

When excision has been performed for tuberculous disease there is little risk of ankylosis following the chief danger is that of a flail like union with no power of extension but this should not occur if care has been taken to preserve the insertion of the triceps over the anconeus into the ulnar shaft and forearm fascia

Alternative operation—When excision is done for ankylosis in bad position the operator may prefer Ollier's bayonet incision to the median straight one (Fig 92 B) The former commences on the inner side above the joint, over the groove for the ulnar nerve, and runs vertically down for 2 inches A similar vertical incision of the same length is made on the outer side below the joint and over the head and neck of the radius These two cuts are joined by an oblique one crossing the olecranon and the 'soft parts' are methodically peeled off the bone and retracted Great care must be taken not to damage the ulnar nerve Of course, the muscles will be atrophied which makes it easier to bare the bone and all trace of ligaments will have gone As soon as the humerus is denuded sufficiently it is cut through with a fine saw (Hey's a metacarpal one or Gigli's saw answers well) and held with bone forceps while the denudation is continued downwards from either side The radius and ulna are probably fused together and should be divided just below the coronoid process with the saw, aided by bone cutting forceps

Note—This operation (excision for bony ankylosis) is a tedious and difficult one it is only justifiable if the bad position in which the forearm is placed renders the arm comparatively useless No prospect of regaining power of extension of elbow can be offered and there is a risk of the arm being weaker than before what is gained in mobility being lost in strength

Excision of the head of the radius—This operation is easily performed through a 2 inch incision below the external epicondyle The external lateral ligament is exposed and the head of the radius found upon the outer side The neck of the radius is divided with a chisel and the head excised A cuff of tissue from the external lateral ligament can be turned down to cover the sawn area of the neck of the radius

Comment—This operation used to be performed very frequently in cases of fracture of the head of the radius and in fracture-dislocation of the head The operation is losing favour at the present time While the immediate results are

excellent, after some years the patient begins to complain of pain and disability It may be said that the operation should never be done in children and in adults only when the head of the radius is so comminuted that replacement is impossible

Excision of the lower portion of the ulna (Gallie Baldwin operation) —Malunion of Colles fractures and cases of loss of pronation and supination are greatly benefited by an excision of 1 inch of the lower quarter of the ulna The periosteum should be removed as well In some cases however mobility is obtained with some loss of power

CHAPTER VII

EXCISION OF THE SHOULDER

THE operation known by this name consists really of an excision of the upper end of the humerus The shoulder joint is not excised—or in other words that portion of the scapula which supports the glenoid fossa is not sawn away with the articular segment of the humerus Portions of bone may be gouged from the glenoid fossa but more than that is seldom done The operation is rarely performed and almost entirely for tuberculous disease In a few instances the upper end of the humerus has been removed for a new growth i e a myeloid sarcoma and now and then in cases of old unreduced dislocation

The operation by an anterior incision —The patient lies upon the back close to the edge of the table with the shoulders well raised

The elbow is flexed and is carried a little from the side The assistant who holds the limb sits or stands by the patient s loins The surgeon takes up a position to the outer side of the shoulder and faces the subject A second assistant stands behind the shoulder facing the operator The bony points about the joint should be defined

1 *The incision* —The incision which is about 4 inches in length commences at the outer side of the tip of the cora coid process and is carried downwards and a little outwards to follow the inclination of the anterior margin of the deltoid muscle (Fig 91 A)

The knife is carried straight down to the joint the coraco acromial arch is exposed and the capsule of the joint is laid bare in the line of the incision The biceps tendon is

next sought for and the capsular ligament is opened vertically just to the outer side of the tendon It is most conveniently incised from below upwards

2 *Separation of the outer margin of the wound* —The operator now proceeds to clear the tissues from the bone upon the outer side of the wound In the case of the right limb this will be the left margin of the wound, and in the case of the left limb the right margin

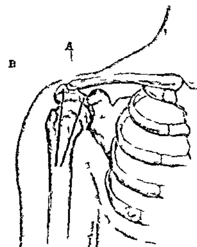


Fig 94 — Excision of the shoulder

A Oblique anterior incision the one recommended and described in the text B vertical incision of Langenbeck and others

The parts are well retracted with the left thumb aided, when required by retractors The surgeon uses a blunt-pointed knife, and separates the soft parts from the upper end of the humerus by cutting on to the bone

The instrument should be kept as close to the bone as possible As the separation proceeds the assistant rotates the humerus inwards, while at the same time he depresses the elbow and forces the head of the bone forwards

The surgeon clears the capsule from the outer part of the bone peeling back and to some extent dividing the insertions of the supraspinatus infraspinatus and teres minor muscle It is neither necessary nor advisable as a rule to divide these completely

The second assistant aids in retracting the soft parts

3 *Separation of the inner margin of the wound* —The limb is restored to the position it originally occupied and the surgeon proceeds to clear the bone upon its inner aspect in the manner just described The humerus is rotated outwards as he proceeds and when the lesser tuberosity is reached the subscapularis insertion is partially detached

In this stage care must be taken of the biceps tendon which should be drawn inwards

4 *Excision of the head and completion of the operation* —The elbow is flexed and the arm is held firmly by the assistant so that the head of the bone is made to project through the wound A broad fan shaped chisel is now used to cut away the whole articular surface of the humerus as shown in the line *e l* Fig 95 Note that this line is convex upwards, and the section of bone should be rounded in the same direction



Fig 95 —Line of section of humerus in excision (*e l*)

A curved elevator passed behind the head is held by an assistant during the chiselling The detached head is now removed

All diseased portions of synovial membrane and capsule are then carefully cut or scraped away with special attention to the bicipital and subscapularis pouches or diverticula from the joint

The surfaces of the glenoid cavity and end of humerus are now examined and any diseased patches of bone in them gouged or chiselled away

After treatment —A drainage tube should be retained by suture at the lower part of the wound for a few days A pad of cotton wool in the axilla is used with the

next sought for and the capsular ligament is opened vertically just to the outer side of the tendon It is most conveniently incised from below upwards

2 *Separation of the outer margin of the wound* —The operator now proceeds to clear the tissues from the bone upon the outer side of the wound In the case of the right limb this will be the left margin of the wound, and in the case of the left limb the right margin

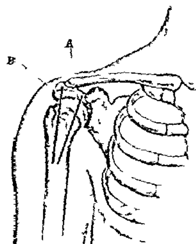


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in situ and to the avoidance of complete division of the rotator muscles One method formerly practised by which the tuberosities were completely bared the humerus pushed through the wound and the section made with a saw through the surgical neck gave but poor results

Langenbeck s incision is placed more to the outer side and has for its starting point the acromio clavicular joint (Fig 94, B) It is distinctly inferior to the one described

Arthrodesis of the shoulder (Fig 96)—This operation is a very satisfactory one Its main indication is in cases of infantile paralysis where there is deltoid paralysis but good scapular control and good use of the hand and forearm A laterally placed incision cutting straight through the deltoid may be used as this muscle is wasted and the circumflex nerve is no longer of importance The glenoid cavity is bared and also the head of the humerus, and a lozenge facet is cut in the latter to receive the glenoid Apposition is not always good and it is often advisable to fracture the acromion process down on to the top of the humerus, thus providing greater fixation Fixation in plaster of Paris until union is solid is the best after treatment The shoulder is fixed in 45 degrees of abduction at the gleno humeral junction and just forward of the coronal plane

somewhat voluminous gauze dressing and even pressure is applied all round the shoulder

The best position for the arm is one of abduction (45° to 60° from the trunk) This may be secured at first by the dressings and pillows, or an abduction splint—fixed to

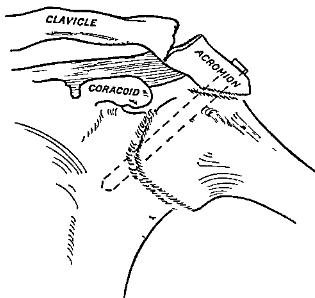


Fig 96.—Arthrodesis of the shoulder joint

The glenoid cavity and the head of the humerus have been denuded of articular cartilage The acromion has been fractured on to a rawed area on the humerus This gives extra fixation

the chest and supporting the arm—may be applied from the first

The fingers, wrist and elbow must be moved regularly Gentle passive motion of the shoulder may be begun in from two to four weeks time

Comment —Several other methods have been employed in excision of the shoulder but we believe this to be the best Much importance is attached to the limited removal of bone

in situ and to the avoidance of complete division of the rotator muscles One method formerly practised by which the tuberosities were completely bared, the humerus pushed through the wound and the section made with a saw through the surgical neck gave but poor results

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CHAPTER VIII

EXCISION OF THE METATARSAL HEAD OF THE GREAT TOE, OF THE TALUS

Metatarsal head of the great toe —In cases where the outward deviation of the great toe and the consequent bursa over the metatarsal head (hallux valgus) cause much inconvenience in walking the following operation may be performed

1 A curved incision convex upwards is made over the neck and head of the metatarsal which will first expose the bursa If this is not inflamed it is turned upwards i e reflected with the fascia covering the bone to be subsequently used for insertion into the gap made by the excision (Mayo) If however the bursa has been or is inflamed it must be removed

2 Clear the tissues all round the metatarsal head so far as is practicable retract them divide the capsule chisel through the neck and lever the head out with forceps aided by the scalpel

Round off the end of the metatarsal shaft

3 Examine the sesamoid bones if they show evidence of osteophytes or are abnormally enlarged excise one or both

4 Expose the displaced extensor tendon and draw it inwards if it is still tense it may be well to lengthen it (*see* p 265) Usually it suffices to fix the sheath of the tendon over the middle of the toe in a normal position by a few sutures

5 If the bursa has been preserved it is turned into the gap and fixed with one or two sutures

The skin wound is closed without drainage and a dressing applied About three weeks must elapse before the patient attempts to walk An alternative operation (Keller) is

similar but the base of the proximal phalanx is removed and the metatarsal head left intact

Simple removal of bone from the inner side of the head may suffice in the less severe cases and the joint is left undisturbed

The talus —This operation may be required for inveterate talipes varus or equino varus and in children is an easy operation In the adult foot where it may be necessary in cases of dislocation or fracture dislocation it is much more difficult as a rule Tuberculous disease is rarely limited to the talus alone

The chief difficulty about the operation lies in the complete division of the talo calcaneal interosseous ligament which occupies the sinus tarsi between the bones

Position of the patient —The patient lies on the back, and the foot is so placed as to extend beyond the end of the table—better a firm block or other support which rests on the table The foot must be held by an assistant who can manipulate it as directed It is best to use a tourniquet

Two incisions external and internal are made The *outer* incision runs parallel with and just posterior to the tendon of the peroneus tertius and commences an inch or two above the level of the articular margin of the tibia

A second and much shorter cut starts from the centre of the principal incision is placed at right angles to it and ends immediately below the tip of the outer malleolus The two slight flaps thus defined are turned aside and the bone is exposed in the interval between the peroneus tertius and peroneus brevis tendons It is important not to injure these peronei tendons

The foot is well extended and inverted and the ligaments which connect the bone with the fibula tibia scaphoid and os calcis are divided so far as they can be reached from the outer side This division will include the anterior band of the external lateral ligament and the interosseous or key ligament between the two bones in its tunnel below the talus which must be reached with the point of the knife while the foot is strongly inverted Retractors are used to protect the tendons etc

and quadriceps tendon may then all be reflected upwards (Figs 102, 103) This gives the fullest possible exposure of the joint Such an incision is reserved for major reconstructive work

Removal of the semilunar cartilages —The limb is completely exsanguinated from toes to the upper thigh by an Esmarch's bandage A tourniquet is then applied and the bandage removed The operation is performed with the knee projecting over the end of the table so that the joint is flexed to 90 degrees—the weight of the limb tends to separate the femur and tibia and the surgeon can move it freely at will The knee is straightened to close the incision An incision is made

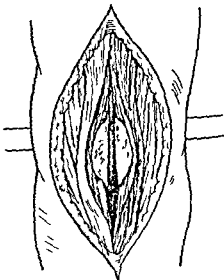


Fig 97.—The split patella method the patella sawn

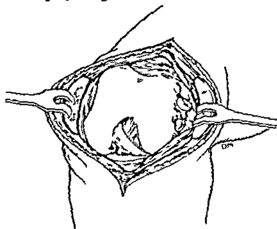


Fig 98 —The split patella method the view obtained

downwards and backwards from midway between the patella and femoral condyle to the upper end of the tibia (Fig 102) The incision is made down to the joint capsule and tetra-cloths are applied With a new knife the capsule and synovial membrane are divided in the line of the incision, and the joint is examined (Fig 103) The internal meniscus

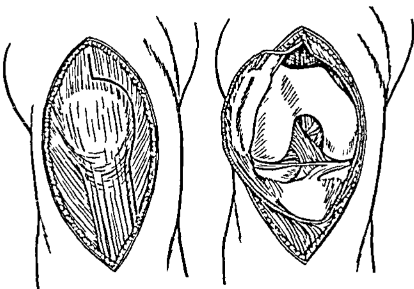


Fig 99 —The method which displaces the patella left the incision following the line of the patella right the view obtained

is divided at its anterior end seized by cartilage holding forceps and separated circumferentially As much as possible of the cartilage is removed The closure of the incision is very important The synovial membrane is very carefully sewn with a continuous stitch which is taken back to include the capsule This stitch controls hæmorrhage from the very vascular synovia after the tourniquet is removed The skin is closed and dressings are applied A very firm bandage is then applied over a generous allowance of wool The tourni

quet is now removed The patient's leg rests on a pillow, no splint being required The firm bandage must not be loosened for two days when all danger of a hæmarthrosis should be over Sutures are removed on the tenth day and the patient is allowed up with a back splint for three days The patient

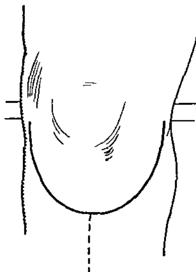


Fig 100 —The widest exposure of the knee the incision

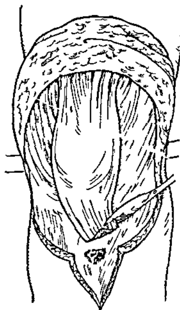


Fig 101 —The widest exposure of the knee the method The anterior tubercle of the tibia is detached and the patella tendon dissected up

is made to contract the quadriceps from the second day after the operation

Indications —The chief indications for excision of the knee are

1 *Tuberculous arthritis in adults* —Here the results of conservative measures are so disappointing that

as soon as the diagnosis is established—by biopsy if necessary—the operation should be performed

2 *Mon articular osteo arthritis where pain is severe* — Cases suitable for surgery of this type are not common as the disease is so often polyarticular

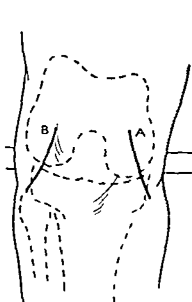


Fig 102 —The approach to the semilunar cartilages

A incision for the internal semilunar cartilage B for the external semilunar cartilage

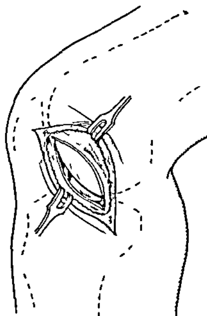


Fig 103 —Exposure of the semilunar cartilage the incision in the capsule and the integuments

3 *Major penetrating wounds* of the knee with gross contamination of the joint Some surgeons consider that a better result is likely from prompt primary excision in such cases than from arthrotomy and drainage and the standard older measures It is a manœuvre worth reflection

Excision should never be attempted in young children nor in elderly subjects Complete excision with the object

quet is now removed The patient s leg rests on a pillow no splint being required The firm bandage must not be loosened for two days when all danger of a hæmarthrosis should be over Sutures are removed on the tenth day and the patient is allowed up with a back splint for three days The patient

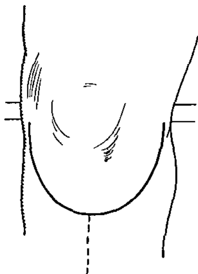


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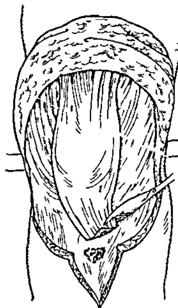


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Indications —The chief indications for excision of the knee are

1 *Tuberculous arthritis in adults* —Here the results of con ervative measures are so disappointing that

Operation by a curved transverse anterior incision.—Of the many methods which have been described and adopted this appears the most suitable

Position —The patient lies upon the back with the limb close to the margin of the table The lower part of the leg should project a little beyond the table so that when the knee is bent at a right angle the foot may be able to rest flat on the sole upon the end of the table

The surgeon stands on the side to be operated upon

One assistant places himself opposite to the surgeon and steadies the limb by the thigh Another assistant near the foot of the table holds the leg and manipulates it as required A third assistant by the surgeon s side attends to the sponging, etc An elastic tourniquet is applied around the thigh immediately before the incision is made after the limb has been held vertically upwards for a few minutes As soon as all the diseased parts have been excised the tourniquet should be removed

At the commencement of the operation the limb is held with the knee a little flexed Later the joint is bent at a right angle

1 *The skin incision* —A curved incision convex downwards is made across the front of the knee below the patella

The incision commences and terminates at the posterior margin of one of the femoral condyles its lowest point in front corresponds with the insertion of the patellar ligament

During the making of this wound the knee joint is held a little flexed and the skin and subcutaneous tissues are alone divided at the first sweep of the knife

2 *Dividing of the ligaments excision of the subcrureus pouch etc* —The knee is now flexed a little more and with another sweep of the knife the anterior part of the capsule and the patellar ligament are cut through and the joint is opened below the knee cap

The patella with its attached aponeurosis is turned upwards the vasti on either side being cut sufficiently to enable the uppermost limit of the pouch of synovial membrane between the quadriceps and femur to be reached This part

of obtaining firm bony ankylosis will alone be described here though it is true an arthrectomy may now and then have succeeded in obtaining a mobile joint Usually the limb after simple arthrectomy, has been a weak one and the disease has recurred one reason being the impossibility of dealing with the pouches behind each condyle unless the latter are cut off (i e excision of the joint)

As the operation is usually performed in young subjects it is important to define exactly the epiphysial lines' The section of the two bones must on no account impinge upon these or growth will be arrested

The upper limit of the femoral epiphysis will be represented by a nearly horizontal line drawn across the bone at the level of the tubercle for the adductor magnus If the whole of the trochlear surface be removed in the excision, the whole of the epiphysis will have been taken away A single nucleus appears in this epiphysis shortly before birth and joins the shaft from the twentieth to the twenty fifth year The epiphysial line is partly intracapsular

The limits of the tibial epiphysis are represented behind and at the sides by a horizontal line that just marks off the tuberosities It includes therefore the depression for the insertion of the semimembranosus and also the facet for the fibula

In front the epiphysial line slopes downwards on either side to a point on the upper end of the shin so as to enclose the whole of the tubercle of the tibia

The centre joins the main bone at the twenty first or twenty second year The epiphysial line is extra articular Farabeuf estimates that in a child of about 8 years of age it is impossible to remove more than 1 cm of the tibia or $1\frac{1}{2}$ cm ($\frac{7}{13}$ inch) of the femur without approaching dangerously near to the epiphysial lines

After puberty (e g in a youth aged 17 years) it becomes possible to remove $1\frac{1}{2}$ cm of the tibia and $2\frac{1}{2}$ cm (1 inch) of the femur, without compromising the epiphysial lines

The popliteal artery is so placed that it is in greater risk of being wounded when the tibia is sawn than when the lower part of the femur is being removed

The bone is sawn from before backwards and with regard to the plane of the section these two points must be observed —

The plane of the saw cut in the antero posterior direction must be at right angles to the long axis of the shaft of the femur and in the transverse direction it must be parallel to the plane of the free surface of the condyles

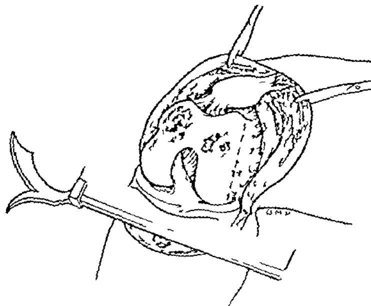


Fig 105 – Excision of the knee the method of sawing the bones

During the sawing process the condyles may be grasped and steadied with lion forceps although if the limb be firmly held this is not necessary The femur rests upon the tibia

4 *Sawing of the tibia* —The upper end of the tibia is now held forward the foot is still pressed firmly against the table the shaft of the bone is maintained in the vertical position and in consequence the articular surface will be

of the joint is always much diseased in tuberculous arthritis and unless its thorough removal is done early it may be over looked by the operator The pouch is carefully dissected out it may sometimes be removed in one piece as low down as the front of the condyles. Over the area enclosed by the dotted line in Fig 104 (left hand figure) it will probably be

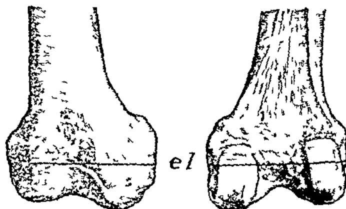


Fig 104 —Line for division of the femur in complete excision of the knee joint (e l)

The surgeon should if possible not remove more than this with the saw dealing with the rest of the cartilage covered surface by means of the chisel The dotted line in front (left hand figure) encloses roughly the area of close adhesion between joint capsule and bone The two dotted lines behind (right hand figure) mark the normal limits of prolongation upwards of the synovial membrane

necessary to cut away a thin surface layer of bone In non tuberculous cases this stage may be omitted

The patella presents some difficulty A good method is to reflect the synovial membrane all round it and then to remove this with the articular surface in one piece by the saw Or the whole bone may be dissected out (this is rarely necessary)

3 *Sawing of the femur* —The joint is now bent at a right angle and the limb held firmly in that position with the sole of the foot planted upon the table

The femur is cleared with the knife at the saw line (Fig 104)

The bone is sawn from before backwards and with regard to the plane of the section these two points must be observed —

The plane of the saw cut in the antero posterior direction must be at right angles to the long axis of the shaft of the femur and in the transverse direction it must be parallel to the plane of the free surface of the condyles

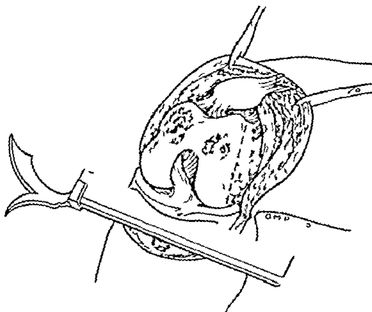


FIG 105 —Excision of the knee the method of sawing the bones

During the sawing process the condyles may be grasped and steadied with lion forceps although if the limb be firmly held this is not necessary The femur rests upon the tibia

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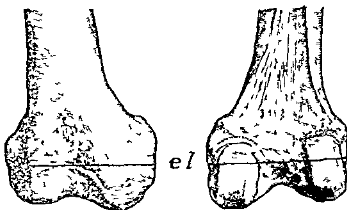


Fig 104 —Line for division of the femur in complete excision of the knee joint (e l)

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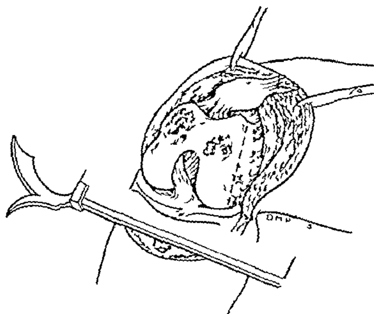


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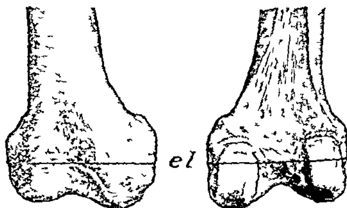


Fig 104 —Line for division of the femur in complete excision of the knee joint (e l)

The surgeon should if possible not remove more than this with the saw dealing with the rest of the cartilage-covered surface by means of the chisel The dotted line in front (left hand figure) encloses roughly the area of close adhesion between joint capsule and bone The two dotted lines behind (right hand figure) mark the normal limits of prolongation upwards of the synovial membrane

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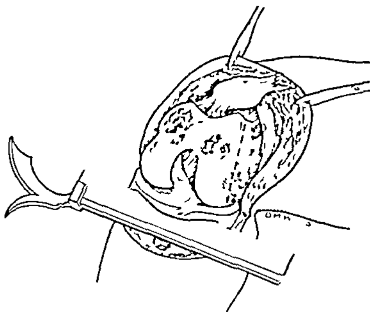


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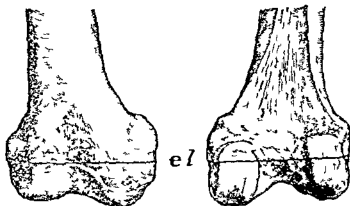


Fig 104 —Line for division of the femur in complete excision of the knee joint (e l)

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3 *Sawing of the femur* —The joint is now bent at a right angle and the limb held firmly in that position, with the sole of the foot planted upon the table

The femur is cleared with the knife at the saw line (Fig 104)

No blood vessels of any importance are divided The arteries actually severed will be branches of the geniculate arteries of the supreme geniculate and of the anterior tibial recurrent

In the majority of instances it is possible to leave the posterior ligament undisturbed, and, in any case, care should be taken to spare this ligament and to separate its attachments from the bones rather than to cut it

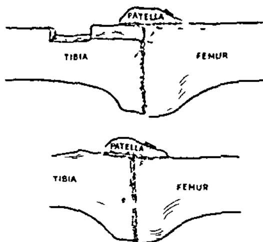


Fig 106.—Excision of the knee alternative methods of fixation

The utmost care must be taken to respect the epiphysial lines in young subjects If they are damaged it will lead to a shortened deformed and probably useless limb

The problem of fixation now arises If perfect apposition has been easily obtained there is usually no need to do any thing further On the other hand in the tuberculous case the bones are notoriously slow to unite and if good apposition is doubtful they are better fixed together Probably long wire nails provide the best fixation they can be allowed to protrude through the plaster of Paris and be removed after three weeks (Fig 106)

quite horizontal The bone is cleared with the knife for the passag of the saw and a thin slice is removed by sawing from before backwards, the saw being kept precisely parallel to the articular surface, and therefore at right angles to the shaft (Fig 105) Whilst sawing through both tibia and femur the operator uses special care as the blade approaches the posterior surface of the bones if this is done there is no fear of damaging the important structures in the popliteal space which are moreover separated by the thick posterior ligament The assistant retracts the soft tissues on either side and if thought desirable a straight spatula may be held behind the bones during the sawing

The two bony surfaces should now be parallel and should fit accurately when brought together

5 *Completion of the operation* —The suprapatellar pouch has already been dealt with but two smaller areas of diseased synovial membrane can only be dealt with after section of the bone namely those behind each femoral condyle The femur is raised for this purpose and the cartilage and a thin layer of bone can be chiselled off from the back of the condyles The whole of the extensive wound is again carefully examined

With the knife and scissors aided by the sharp poon the surgeon now proceeds to remove any disea ed synovial membrane which may remain

The tourniquet is removed and any bleeding vessels are ligatured As a rule the chief hæmorrhage is from the bones and will cease of itself

The part is now well flushed with sterilized warm water and carefully dried

Nothing remains but to close the wound with sutures—ilkworm gut being the best for the purpose—and to adjust the limb upon the splint which has been prepared for its reception

If drainage is considered necessary a small tube at either side may be inserted to be removed at the first dressing Many operators dispense with drainage trusting to a firm bandage over the dressing It is well to elevate the whole limb the splint resting on an inclined plane

CHAPTER X

THE HIP JOINT

Excision of the Hip

This operation implies the removal merely of the upper end of the femur and the scraping away of any diseased tissue which may occupy the acetabulum As in the shoulder joint so here also, the excision does not involve the whole joint and the entire articulating surfaces

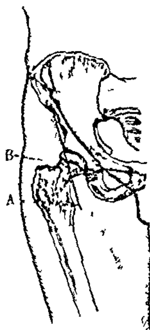


Fig 107 — Excision of the hip

A line of incision B line of division of neck of femur

Surgeons differ exceedingly in their estimate of the value of this operation but, considering the great frequency of tuberculous disease of the hip it is found advisable in only a very small percentage of the cases Perhaps the most suitable are those in which the X rays reveal the presence of a sequestrum in the neck or head of the femur The operation is also occasionally required for osteomyelitis of the femoral neck

Operation by anterior incision —The patient lies supine with both thighs fully extended The surgeon stands on the outer side of the limb to be operated upon one assistant facing him holds the affected thigh, another stands beside and to the left of the operator

External fixation must be meticulous Plaster of Paris is the only adequate agent If the thigh is long and not fat the hip need not be included After a preliminary recumbent period, which in the tuberculous case should be lengthy, the patient may be allowed to walk in the plaster

Comment —The sooner the patient can get about bearing pressure through the foot, the better But for a long time some form of support to the knee must be worn otherwise bending at the line of union is very apt to occur

There are many variations of incision For example Sir William Macewen employed a horseshoe one convex *up wards* the top of the curve some distance above the patella—this with a view to dealing thoroughly with the suprapatellar pouch Kocher advocated a single (external) lateral incision, curving forwards below the insertion of the ligamentum patellæ which is detached by the chisel and the flap turned inwards Some surgeons have split the patella and the quadriceps through a median incision—this method hardly gives sufficient room

having been cleared out by means of the rush of warm water, aided by the use of a large scoop, the neck of the femur is sawn across with a narrow saw in the direction of the external wound or it may be cut through with a broad chisel If a fan shaped chisel be used, the section may be made somewhat rounded (Fig 107, B) The diseased head can then be lifted out by means of an elevator and sequestrum forceps

Now commences the search for further disease This can usually be estimated by the left forefinger with which the

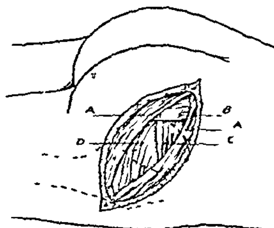


Fig 109.—Posterior approach to the hip joint

AA gluteus maximus split B sheath of sciatic nerve and vessels C obturator internus D quadriceps femoris

acetabulum is first examined and then all the other parts of the joint-cavity Wherever diseased material is felt, it is cut away by the gouge or scoop the hot water carrying away the debris as fast as it is produced, and with it all blood, while at the same time it arrests bleeding from the freshly cut surfaces When every part of the field of operation has been gouged and scraped clean of all tuberculous material and the water runs away clear the cavity is dried with sterilized gauze a pad of which is left in it until all the stitches are placed in position These should dip deeply and be placed

The most precise and rigorous aseptic measures are carried out It is not practicable to apply a tourniquet

The incision commences on the front of the thigh, half an inch below the anterior spinous process of the ilium, and runs downwards and a little inwards for 3 inches (Fig 107 A) As the knife sinks in it passes between the tensor fascia lata and glutei muscles on the outside and the sartorius and rectus

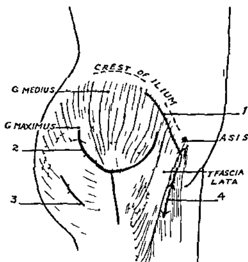


Fig 108 —Exposure of the hip joint

1 Smith Petersen s incision 2 Murphy s or the goblet incision 3 the posterior approach 4 the anterior approach or Langenbeck incision *Note* 3 and 4 are used only for simple procedures such as drainage the Smith Petersen incision is the upward prolongation of 4

femoris on the inside until it reaches the neck of the femur This incision does not divide any muscle fibres nor vessels or nerves of any importance The reflected head of the rectus will probably be divided and branches of the lateral circumflex artery If an abscess is opened up before the joint is reached its contents are thoroughly flushed out with sterilized warm water at a temperature of between 105 and 110° before anything further is done The abscess

of the femur is thrust into the acetabulum and secured there

Now when all this has been done although there remains potentially a cavity, there is actually nothing of the kind for all the surfaces have been brought into apposition And then, assuming that perfect asepsis has been observed, all these surfaces ought to unite with a minimum of exudation It is usually advisable to insert a small rubber drain, which

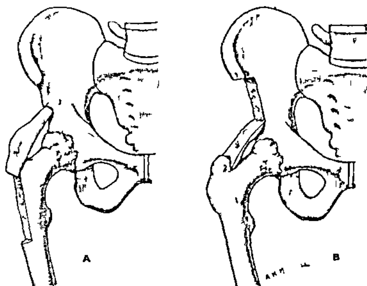


Fig 111 —Alternative methods for the performance of extra articular arthrodesis at the hip joint

A great trochanter excised and reversed thrust into ilium B shelf turned down from ilium and wedged into great trochanter

emerges through a specially made opening at the back The tube is removed at the first dressing The hip and limb are encased in a firm hip spica of plaster of Paris A window is cut for removal of the sutures

The operation as above described is classical but seldom required Of much greater practical importance are the following operative procedures

close together Just before they are tied the sponges are removed and with them the last traces of moisture Care should be taken lest fragments of gauze be left in the recesses When there has been extensive swabbing of rough bony surfaces it is quite easy for this to happen

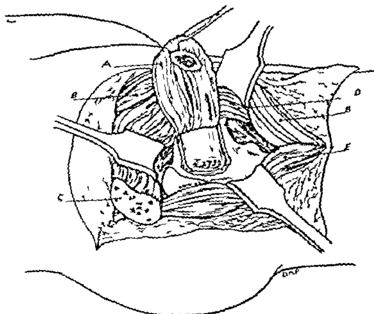


Fig 110 —Major exposure of the hip joint

The goblet incision has been used The trochanter is displaced up and the joint approached along the anterior aspect of the neck of the femur A capsule of hip joint opened by chipping off the tubercle BB tensor fasciæ latæ C great trochanter chiselled off and turned up D rectus femoris F gluteus maximus

The whole joint is covered with aseptic gauze so adjusted that evenly graduated pressure is brought to bear upon every aspect of the field of operation while the limb is held well abducted If the dressing be now well compressed with a spica bandage the walls of the whole clean scraped cavity are brought into contact and the remainder of the neck

required Hæmorrhage may be troublesome however, and it is sometimes simpler to detach the great trochanter In simple drainage neither of these expedients will often be called for, as the capsule can be found between the muscles

B Arthrodesis of the Hip Joint

This may be performed as an intra articular or extra articular procedure, or not infrequently by a combination of the two methods The extra articular method is reserved

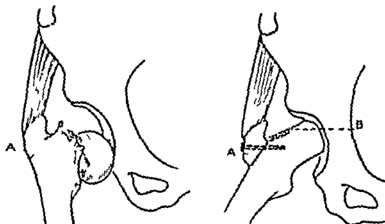


Fig 113 —Whitman s reconstructive operation as performed for an old fracture of the femoral neck It has other indications

A (left) great trochanter showing line of section A (right) great trochanter replaced at lower level B original site of trochanter

for cases where there has been previous infective or tuberculous arthritis and it is undesirable to risk a ' flare up of infection

The best approach is that attributed to Murphy (the goblet incision) (Figs 108 2 112) The great trochanter is detached with part of the femoral shaft This is then rotated through 180 degrees and the upper end of the femoral shaft is driven into a bed cut in the ilium just above the joint (Hibbs) (Fig 109 A) In the intra articular method the joint is opened and the head of the femur and the acetabulum are denuded

A Drainage of the hip joint
B Arthrodesis of the hip joint
C Arthroplasty of the hip joint

A DRAINAGE OF THE HIP JOINT

This may be obtained either by the antero lateral approach or by the posterior route The former is the more common It is the one described under excision of the hip The operation is usually adequate though it does not give dependent drainage If this proves inadequate then posterior drainage is involved This can sometimes be done by a modified method cutting down upon forceps inserted in the joint from the anterior

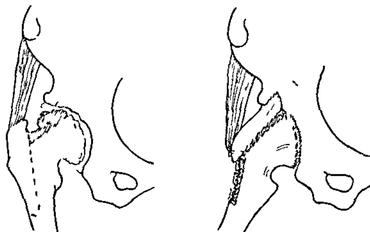


Fig 112 –Extra and intra articular (combined) arthrodesis of the hip joint

approach The formal posterior approach is made through an) shaped incision from the posterior superior iliac spine to the top of the great trochanter and then down the back of the shaft of the femur (Fig 108 3) The gluteus maximus is split in the line of its fibres and the interval between the medius and minimus above and the pyriformis below is sought (Fig 109) The pyriformis and the obturator may be divided at their insertions if greater access is

required Hæmorrhage may be troublesome, however, and it is sometimes simpler to detach the great trochanter In simple drainage neither of these expedients will often be called for as the capsule can be found between the muscles

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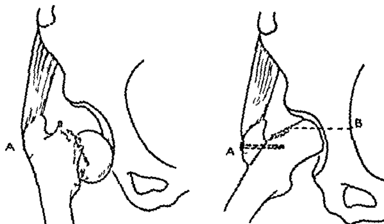


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of articular cartilage It is advisable to fix an extra articular graft in addition in these cases (Fig 112) Unfortunately the dislocation of the head of the femur from the joint in order to denude it of cartilage is a procedure which causes a great deal of shock In many cases arthrodesis may be replaced by a weight relieving osteotomy

C ARTHROPLASTY OF THE HIP JOINT

In cases of bilateral ankylosis of the hips an arthroplasty is an absolute indication Otherwise the operation is less frequently performed than the ones described above Whitman s operation is probably the most useful The joint is exposed by Murphy s route the great trochanter being completely detached from the neck and shaft of the femur The head of the femur is excised and the upper end of the neck rounded off This is then inserted into the acetabulum and the trochanter is re attached lower down the shaft of the femur In this way the leverage of the important balancing muscles the glutei is preserved (Fig 113) After treatment consists in suspension in abduction with early gentle movements

Other approaches to the hip-joint —The method of Smith Petersen requires mention He makes use of the Langenbeck incision below with extension upwards curving with the outer lip of the iliac crest and some half inch below it (Fig 109 *I*) The muscles arising from the ileum are detached subperiosteally at their origin A wide exposure is obtained

Operation for insertion of Smith-Petersen's Pin — For cases of fracture of the neck of the femur in adults the introduction of a triflanged stainless steel pin gives good results After exposure of the joint by means of Smith Petersen s incision the capsule is incised and the fracture reduced A pin the length of which has been previously estimated, is then driven through the great trochanter Rotation of the leg outwards will determine whether it is appearing at the mid point of the fractured neck If so, internal rotation of the leg is repeated and the pin driven home If not the pin must be extracted and the process repeated The wound is closed in layers and a firm dressing is applied The patient is allowed up at the end of a month

VITALLIUM CUP ARTHROPLASTY OF HIP

This method introduced by Smith Petersen is still in stages of trial Final judgment cannot be pronounced but it has extended the indications for arthroplasty of hip A vitallium cup is introduced to provide a mould upon which new articulating surfaces may form It precludes the formation of adhesions between these surfaces and secures an even distribution of weight so hindering the absorption of bone which results so frequently with other methods

Indications 1 A stiff and painful hip
2 A subject of good mental and physical make up
3 Good musculature round the joint
4 Sufficient bone on each side of the proposed joint to accommodate the cup

Contraindications 1 Tuberculosis at any stage
2 Where any other old infection might be lighted up
3 Where demands on the limb are likely to be heavy arthrodesis is still preferred

Preparation A course of intramuscular Penicillin injections is commenced 24 hours before operation and a blood transfusion started before the skin is incised

A sand bag is placed under the buttock of the affected side

Operation Smith Petersen s incision is made along the anterior third of the iliac crest and down the lateral border of sartorius for 5 inches The interval between sartorius and tensor fascia lata is opened The gluteus medius minimus and tensor fascia lata are detached from the ilium and retracted laterally Sartorius is detached from the anterior superior iliac spine medially the iliacus muscle is stripped subperiosteally and retracted It is an essential step to define the anterior superior iliac spine clearly with adequate stripping on the medial and lateral aspect of the joint Rectus femoris is detached and turned down from the anterior inferior iliac spine care being taken to preserve its nerve supply

The anterior aspect of the joint capsule is now exposed and it is excised with the ilio femoral ligament

To assist in dislocation of the femoral head from the acetabulum the anterior rim of the latter is chiselled away This should be done widely to ensure ultimate free movement of the remodelled joint The acetabulum is cleared of osteophytes and the anterior inferior iliac spine is removed with an osteotome The original joint line must be clearly defined above and below In cases of ankylosis separation is secured by driving a curved osteotome shaped to the femoral head into the mass along this line The head of the femur is then dislocated forwards by adduction and external rotation of the thigh

The remainder of the joint capsule is now carefully excised and the posterior rim of the acetabulum is trimmed of osteophytes The articular surfaces of the acetabulum and the femoral head are smoothed first with an osteotome and then with curved male and female reamers

A vitallium cup of size just sufficient to be a loose fit for the femoral head is chosen The acetabulum is deepened to allow the cup to move freely within it The femoral head with cup is now placed in position The anterior aspect of the joint is covered by refining the gluteal muscles and tensor fascia lata to the iliac crest As a result of the reconstruction the anterior iliac spine is unduly prominent and is removed with an osteotome Rectus femoris is sutured to the gluteal muscles in the line of its former attachment Sartorius is sutured to the periosteum at the new anterior limit of the iliac crest The wound is then closed

The limb is now placed on a broad webbing strap extending along the calf and thigh 5 lbs wt traction is applied by strapping or by a pin inserted through the tibial crest the latter is preferable as it is easier to maintain slight medial rotation of the leg Pain is usually slight

Muscle drill is started twice daily after 24 hours Skin sutures are taken out after 10 days and joint movements are then commenced Traction is discontinued after 4 weeks weight bearing with a walking frame is allowed after 6 weeks Full weight bearing is not permitted until 6 months after operation

CHAPTER XI

OPERATIONS ON THE JAWS

Excision of the Upper Jaw

Lateral Rhinotomy (Moure's Operation)

This operation is the most effective and satisfactory method of removing growths of the maxilla or neighbouring portions of the nasal cavity which do not encroach on the mouth The interior of the nose is treated with cocaine and adrenalin the patient anæsthetized and the posterior choana plugged An incision is made from just below the inner end of the eyebrow down the side of the nose skirting the ala nasi (Fig 114) The soft tissues are dissected back so as to expose the infra orbital border and the bony margin of the anterior nasal orifice, from which the cartilages are detached Incisions are then made through the bone with hammer and chisel as follows (Figs 115 116) One upwards and outwards through the nasal process of the superior maxilla or between it and the nasal bone a second more or less parallel to it running from the lower border of the nasal aperture to the infra orbital border close to the infra orbital foramen and a third joining the two running parallel to the infra orbital border, either on the facial or orbital aspect as is thought best

The portion of bone thus marked out usually including a small section of the floor of the orbit is twisted out of its bed by forceps laying bare the lachrymal sac and canal The amount of bone removed varies necessarily with the case but a considerable opening into the antrum and nasal cavity is secured and growths in this region can be readily removed

The incisions are subsequently closed by sutures and the resulting deformity is very slight

This operation is only performed for malignant diseases sarcoma or carcinoma In the case of an epithelioma starting in the alveolar portion it will of course be unnecessary to

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The operation may involve considerable hæmorrhage and shock as well as the risk of subsequent pneumonia (perhaps from blood getting down the trachea) These dangers are minimized by the intratracheal administration

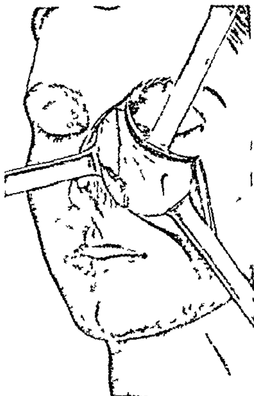
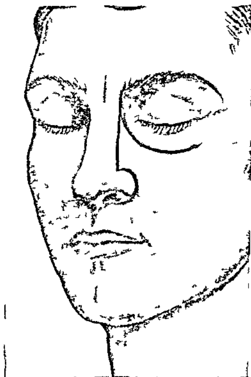


Fig 116 —Moure s operation
The lines of section of the bones are marked out

of ether and by preliminary ligature of the external carotid artery on the same side By the latter step not only are all vessels going to the upper jaw cut off but through the incision any perceptible glands can be excised The extra time involved should not be great and is well compensated

remove the whole upper maxilla, and in some other cases it may be possible to leave the orbital floor—a great advantage to the patient It is impossible to describe here the various forms of operation owing to limitation of space we can only deal with the complete removal of one superior maxilla including its upper or orbital portion



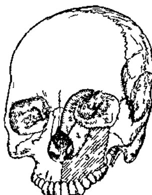


Fig 115

Fig 114.—Lateral Rhinotomy (Moure s operation)

In Fig 114 the extent of th cutaneous incisi n for a l mited operation i indicat d by the thick line ea 1 of Fig 115 *can be dealt with in thi way* If th ethmoidal and frontal sinuses a inv d d the incision is carried upwards and outwards along the sup a rbit l margin and area ? of Fig 115 can be cleared If a large extent of the uperior maxilla or pa t of the upp r alveolus is involved the lip is split in th midlin and ar a 3 of Fig 115 can be operated on and removed if necessary

which limits the ala nasi and skirting the nostril reaches the median line of the upper lip

When the lip is reached the chief assistant grasps each extremity of the lip (at either angle of the mouth) between the finger and thumb so as to compress the coronary arteries The incision is then carried through the median line of the upper lip into the mouth (Fig 117 A)

The superior labial arteries are at once seized and secured These vessels anastomose so freely across the middle line that the ligature of the external carotid will not have been sufficient The same applies to a lesser extent to the other branches of the facial artery involved in the wound

2 A second incision is now carried along the lower margin of the orbit At its commencement it starts from the point of the first incision, it ends over the malar bone

3 The cheek flap thus marked out is now rapidly raised from the bone and should contain all the soft parts down to the maxilla

No attempt should be made to save the periosteum

Throughout the operation sponge pressure is the main means of checking hæmorrhage

4 The operator now separates the nasal cartilages from the bones and divides the nasal process This may be done with a fine saw or a chisel He proceeds to divide the periosteum along the lower edge of the orbit With the elevator the periosteum of the floor of the orbit is carefully raised and in effecting this the origin of the inferior oblique muscle is separated

With a fine chisel the orbital plate may be divided as far within the orbit as is necessary The chisel cut will commence at the point at which the nasal process of the maxilla has been divided and will end at the spheno maxillary fissure If it be considered necessary to take away the whole of the orbital plate of the maxilla, then a chisel cut can scarcely avail and the bone must be wrenched away from its attachments in the final act of removal

The junction of the malar bone and superior maxilla is now

The patient lies upon the back with the head and shoulders well raised The face, if the patient be a male should have been already shaved

Injections of morphia and atropine should have been given an hour before the patient is brought to the theatre

The operation —The first step concerns the anæsthetist who passes the rubber tube for intratracheal anæsthesia When this is in place and the patient under, the surgeon makes a free incision in the neck for exposure of the external carotid and any affected glands The former is ligatured (*see* p 35) and all lymph glands accessible in the neighbourhood are removed The wound is sewn up and a small dressing of gauze and collodion applied

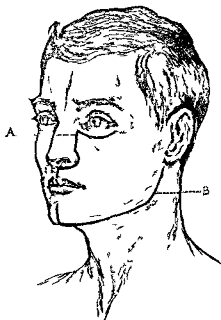


Fig 117 —Excision of the jaws

A Excision of the upper jaw by a mediolateral incision B excision of the lower jaw

The pharynx is blocked with a sponge secured by a long silk ligature this will not interfere with the anæsthetic tube and will intercept bleeding

The preliminary stage being thus completed the main incision is made that devised by Ferguson (who first performed this operation) is still the best

1 The incision is commenced at a point half an inch below the inner canthus is carried down by the side of the nose—where the nose joins the face—follows the groove

which limits the ala nasi and, skirting the nostril reaches the median line of the upper lip

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The junction of the malar bone and superior maxilla is now

cut across in a line running backwards to the spheno maxillary fissure (readily felt) It is improbable that the tumour will involve the malar bone itself, and therefore the section need involve very little of this bone it crosses vertically the suture between the two A frequent error is to carry the section too far outwards As to the cutting instruments used here the bone is normally very dense and a Gigli s saw would probably break the section is best begun with a small Hey s saw and completed with the chisel

5 The palate part of the bone alone remains with its con nexions undisturbed The mouth having been well opened the central incisor tooth on the diseased side is removed the muco periosteal covering of the hard palate is divided in the median line and a knife is drawn along the floor of the nose from before backwards and as near as possible to the septum By means of a transverse incision made through the mouth the soft palate is loosely separated from the hard

A keyhole saw is now introduced through the nose and the bony palate divided near to the median line or the bone cutting forceps are used instead of the saw

There may be some bleeding from the anastomosing palatine arteries

6 The surgeon finally grasps the bone with lion forceps holding the instrument with its blades opened vertically One blade takes hold of the orbital plate and the other of the alveolus The maxilla is then wrenched from its few remain ing attachments These will in part concern the orbital plate and in part the attachment existing between the maxilla and the pterygoid process The separation of the bone from the last named process may be aided by bone cutting for ceps bent at an angle and introduced behind the maxillary tuberosity

Care must be taken at this stage that the soft palate is freed completely from its connexions with the hard

When grasping the bone with the forceps care should be taken not to crush it up

7 Any bleeding from the depths of the cavity should now be checked so far as is possible

It will usually be desirable to plug the cavity with a long strip of gauze to which a silk thread is attached, brought out of the mouth and fastened to the cheek

The skin wound is finally united very carefully with silkworm gut sutures special care being taken accurately to adjust the red margin of the lip

The cavity in the mouth will need gentle irrigation from time to time with a warm antiseptic solution It is surprising how quickly the gap fills up An obturator may be fitted subsequently by the dental surgeon

Comment —When the tumour has involved the central mass of the maxilla and not merely the alveolar border the prognosis is not good If it has encroached on the nose up to the orbit or infiltrated the cheek, the operation is rarely worth doing and radio therapy should be undertaken

Operations on the Lower Jaw or Mandible

The following will be described

1 Excision of one half the bone—usually performed for tumour
2 Excision of part of the ascending ramus for ankylosis
3 Excision of the neck and condyle for the same condition

But besides these formal operations many others are performed involving removal of a part of the horizontal rami or bridging a gap caused by previous removal traumatic or otherwise The great aim of the surgeon is to maintain or restore the mandibular arch effected sometimes by leaving the inferior border of the jaw sometimes (as in cases of phosphorus necrosis) by leaving the periosteal sheath or by bridging a defect by means of a bone graft

1 Excision of one-half the mandible (from condyle to near the symphysis) —Note that it is essential to divide the bone on one side of the mid line thus preserving the attachments of the genio hyoid and genio glossus muscles also

that such an extensive removal in the living patient is a serious mutilation (much worse than the sacrifice of the upper jaw) and is therefore rarely performed It is however a frequent test in examination work

Special instruments required —Lion and strong bone cutting forceps narrow bladed saw, sponges and sponge holders tooth extraction forceps stout curved scissors

The patient lies upon the back with the head and shoulders raised and with the trunk close to the edge of the table The surgeon stands on the side to be operated upon. Some find it more convenient to stand on the patient s right in dealing with either side of the mandible

The head is turned to the sound side The chief assistant takes his place opposite to the surgeon. A second helper stands by the operator s s de

In male subjects the chin will have been already shaved. A long loop of silk ligature is passed through the tongue in readiness for traction when required Intra tracheal ether administration is the best

1 A vertical incision is made through the tissues of the chin in the middle line starting just below the lip which is not divided From the chin this is carried along just below the inferior border of the jaw for its entire length and is then directed upwards along the posterior margin of the ascending ramus to end at or somewhat below the level of the lobule of the ear (Fig 117 B)

The median part of the incision may be superficial so that the mouth is not opened until a later stage it may be superficial also where it crosses the facial vessels elsewhere the knife cuts to the bone

After the incision has been made the surgeon returns to the spot indicated exposes the facial vein and artery by dis ec tion secures them between two ligatures and divides them

With a periosteal elevator or rugine the muscles attached to the external surface of the mandible are rapidly separated from the bone and are turned up with the integuments in the form of a flap The separation is commenced at the symphysis and carried backwards The buccinator and

mas eter are peeled off from the bone in this part of the operation The mental and masseteric arteries together with some smaller branches are divided at this stage

It is desirable that the operator should keep close to the bone

The cavity of the mouth is opened by dividing the buccal mucous membrane at its junction with the alveolus The assistant uses the sponges on holders to keep the mouth dry

ii The surgeon now extracts one of the incisor teeth—the lateral incisor as a rule—and with a keyhole saw divides the jaw vertically in the line of the gap to one side of the middle line i e that of the portion removed Of course the more of the 'symphysis that can be left the better It is often more convenient to saw the bone nearly through and then complete the section with specially strong bone cutting forceps

iii The anterior extremity of the divided mandible is now drawn outwards and, with the knife kept close to the bone, the surgeon divides the attachment of the mylo hyoid muscle The internal pterygoid muscle is reached, and may be conveniently separated from the bone by means of a periosteal elevator The lower border of the mandible is twisted outwards in order that the whole of the attachment of the internal pterygoid muscle may be dealt with

The inferior dental artery and nerve are exposed and divided In this part of the operation care must be taken to avoid injury to the parotid and submaxillary glands

iv The anterior part of the jaw is now forcibly depressed to bring the coronoid process into view in the posterior part of the wound

The tendon of the temporal muscle is divided with scissors curved on the flat as each part of the fibres of insertion is successively reached

Some surgeons divide the coronoid process with a chisel and mallet and subsequently dissect out the fragment of bone thus isolated

The jaw is still further depressed in order that the condyle may be brought into view

The external pterygoid muscle is reached and is detached with the elevator or divided with scissors The capsule of the joint is severed the articulation is opened and the condyle freed Throughout this stage of the excision the jaw should be merely depressed, it should not be twisted If it be much everted or rotated out the internal maxillary artery may be brought into contact with the neck of the bone and may be accidentally divided or even torn

It only remains now to cut the bone free of its few surviving attachments which are represented by the internal lateral stylo mandibular and pterygo mandibular ligaments together with more or less fascia and the remaining fibres of the outer pterygoid muscle

All bleeding having been checked the wound is united with silkworm gut sutures The chin part of the incision should be adjusted with special care It may be possible to unite the wound inside the mouth to some extent with fine catgut sutures A drainage tube may be introduced into the hinder part of the wound, and retained there for twenty four hours or more

During the next week the mouth should be kept clean by frequent use of a weak antiseptic solution

Note—Supposing that a portion of the horizontal ramus only has to be removed the mouth wound is allowed to heal soundly before transplanting a bridge of bone (from the crest of the ilium or tibia of the patient) At the second operation the external scar is opened up again and the jaw fragments are cleared so as to make room for the insertion of the graft, which is fixed in place by means of two small metal plates with screws—one plate at either end of the graft The latter is then completely buried by uniting the wound Good results have been obtained with grafts up to 3 inches long An interval of about three months is advised between the operations

2 **For ankylosis** the neck and condyle may be removed or a wedge of the whole width of either the ascending or the horizontal ramus The former operation is attended with more risk (especially to the facial nerve and internal maxil

lary artery) than the latter, the result of which, moreover, is held to be more certain Hence many surgeons prefer resection of the jaw to that of the condyle There are two varieties of method

(a) **Esmarch's operation** —In this operation a wedge shaped piece of bone is removed from the horizontal portion of the mandible with the intention of establishing a false joint

The wedge of bone to be removed must be taken from the horizontal ramus of the jaw, anterior to the masseter and in front of the contracted tissues The base of the wedge will be below and in an ordinary case in an adult should measure 1¼ inches The apex of the wedge is at the alveolar border and should be about three quarters of an inch in width

An incision some 2 inches in length is made along the lower border of the jaw at the spot at which it is intended to remove the wedge The bone having been well exposed and the periosteum divided a wedge of bone is removed with a keyhole-saw aided by the chisel and a periosteal elevator After all bleeding has been checked the wound is closed by sutures

(b) **Excision of a wedge above the angle** —An L shaped incision at the posterior border of the ascending and horizontal ramus (not reaching as high as the lobule) will allow exposure of the bone which is to be cleared, by knife and rugine, of masseter and internal pterygoid muscles these are pushed upwards The saw marks out a broad wedge of the bone with its truncated apex opposite the last molar tooth The bone having been cut through partially (it is very dense and difficult to saw here) the section is completed with bone cutting forceps The inferior dental vessels and nerve are of course, divided To prevent any risk of sub sequent union a flap of masseter muscle should be turned into the gap and sewn to the internal pterygoid

3 *Excision of the condyle of the jaw* —This opera tion is identical with the so called excision of the temporo mandibular articulation (*See* page 198)

PART V—TENOTOMY, INCLUDING OPERATIONS FOR THE DIVISION OF CONTRACTED MUSCLES, LIGAMENTS, AND FASCIÆ

CHAPTER I

GENERAL CONSIDERATIONS AND PARTICULAR OPERATIONS

General Considerations

The subcutaneous method—The object of this method is to divide the tendon with the least disturbance of the surrounding parts and with the smallest possible division of the skin Before the introduction of the antiseptic method of treating wounds the subcutaneous operation was all essential It is now much less important At the present time it need only be carried out when convenient The same care should be taken with regard to asepsis as in the open method

In any case in which the tendon is not manifest or is difficult to discover or in which its relations with nerves and vessels are complex and intimate it is better to adopt the open method and to expose the area of the operation by a free incision For example the sterno ma toid muscle should always be divided by the open method as being safer and more efficient than the subcutaneous one

Use of the tenotome—The tendon or band of fascia to be divided is usually unduly prominent or can be readily made distinct

The tenotome should be lightly held as one would hold a pen The sharp pointed instrument is carefully introduced

close to the tendon and makes a way for the blunt pointed instrument It is essential that it should make an ample passage for the blunt pointed tenotome and therefore the cutting point may need to be moved freely to and fro in the region of the tendon If this be not done, the blunt tenotome may have to be forced to its destination through tissues that have been merely punctured.

The sharp tenotome is withdrawn and the blunt instrument introduced with the blade "flat"—that is in a line with the line of the skin wound

The instrument should throughout be kept close to the tendon or band to be divided and care must be taken to avoid damage to adjacent vessels or nerves The breaking of the point of the tenotome against the bone is a quite possible accident

As the tenotomes are being introduced the tendon should be only stretched to such an extent as is necessary to render its position distinct It needs to be stretched to its utmost when its fibres are being divided but this tension may be a little relaxed as the last strands are being cut The tendon is divided with a sawing movement it cuts with a creaking sound or sensation and yields finally with a snap A common source of failure after this operation is an incomplete division of the tendon

The left forefinger should be kept upon the skin at the site of the operation in order that the movement of the tenotome beneath the integument may be followed and guarded

PARTICULAR OPERATIONS

Tibialis anterior tendon—This tendon descends through the innermost sheath of the annular ligament and crossing the ankle joint talus scaphoid and first cuneiform bones is inserted into the inner side of the last named bone and the base of the first metatarsal bone The synovial sheath which accompanies it extends upwards for some distance above the level of the malleoli A small bursa lies beneath the tendon as it crosses the cuneiform bone

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base of the malleolus, and therefore above the inner annular ligament The tendon is here easily approached, and is at some distance from the blood vessels

The tendon may also be divided below the malleolus, together with the tibialis anterior and certain ligaments (see p 253)

Operation —The surgeon stands to the outer side of the limb in the case of either tendon The assistant faces him, and grasps the foot with one hand and the leg with the other

The position of the tendon is made out, and the foot is held a little extended and abducted, and is so turned as to lie upon its outer side

The surgeon seeks for that point on the inner surface of the tibia where the malleolus joins the shaft of the bone He reaches this point by following the posterior margin of the malleolus The spot in question will be about a finger's breadth above the tip of the malleolus in the infant, and about 1½ to 2 inches above that process in the adult It is really on the shaft and is above what would be called anatomically the base of the malleolus

The surgeon fixes his left thumb nail upon the margin of the bone and enters the sharp tenotome vertically between the tibia and the tendon, using the nail as a guide The instrument should be kept as near as possible to the bone If properly inserted it will remain fixed without any support from the hand The tendon should not be too tightly stretched at this stage of the operation

The fascia about the tendon should be freely divided by moving the point of the instrument to and fro but without enlarging the skin wound Unless this be done a proper way may not be made for the blunt pointed instrument

As the sharp tenotome is withdrawn the blunt one is introduced—the edge is turned towards the tendon—the tendon is put upon the stretch and is divided by cutting from the bone The left forefinger placed over the site of the tendon forms a guide and a guard The tendon of the flexor longus digitorum is usually cut at the same time and is often divided unconsciously;

This tendon is usually divided as it is crossing the scaphoid bone and consequently about an inch above its insertion The dorsalis pedis vessels lie to the outer side, with the extensor longus hallucis tendon intervening

In cases of congenital club foot the tendon is displaced inwards and is nearer to the malleolus It is readily made prominent

Operation —The surgeon stands on the outer side of the limb in the case of either tendon The assistant who takes his place opposite to him grasps the foot with one hand and the leg with the other The foot is held in the position of dorsiflexion and abduction and the tendon is defined The sharp tenotome is then entered vertically upon the outer side of the tendon and is pushed downwards until it has reached a point below the level of the tendon The operator s left fore finger is kept over the skin upon the plantar side of the tendon as a guard upon the instrument The tendon is put on the stretch The sharp tenotome is withdrawn and the blunt pointed one inserted in its place After it has reached the depth attained by the first instrument (whose track it exactly follows) the foot is relaxed and the blunt point is pushed horizontally beneath the tendon and may be felt on its plantar side The tendon is once more put upon the stretch and is divided by cutting upwards towards the skin The left fore finger lies upon the skin over the edge of the knife and forms a certain check to its movement The surgeon cuts indeed, upon the left finger the skin intervening

Tibialis posterior tendon —The tendon becomes free of muscular fibres about the level of the tibio fibular articulation It grooves the back of the inner malleolus running in the innermost compartment of the internal annular ligament Behind the malleolus it is invested with a synovial sheath The flexor longus digitorum tendon lies next to it (on its outer side) and is provided with a separate synovial sheath Externally to this latter tendon run the posterior tibial ve s ls

The tendon is usually divided above the point of com mencement of its synovial sheath i e about the level of the

towards their deep surface as the assistant everts the foot Care must be taken not to endanger the artery and nerve at the outer end of the wound Tenotomy or lengthening of the tendo Achillis may be required later if any equinus persists

If necessary, the plantar fascia may also be divided the best place being where it is narrow—beneath the transverse crease shown in Fig 118 The tenotome is introduced between the skin and fascia and made to cut the latter towards the deep part of the foot

Steindler's operation—This operation was introduced for the treatment of pes cavus This obstinate deformity (when requiring operative measures) is best treated by tendon transplantation on the dorsum of the foot (inserting the long extensors into the necks of the metatarsals) However, some form of section of tight structures on the sole of the foot may be necessary Tight bands can be tenotomized and in rare cases the complete Steindler operation performed The original operation was performed through a U shaped incision encircling the heel It is now more common to use a horizontal incision on either the inner or outer side of the heel The incision is about 1 inch above the sole level All structures arising from the under side of the os calcis are detached from the bone This includes the long and short plantar ligaments The foot is then vigorously wrenched and these structures slide forwards The incision is closed and the foot immobilized in plaster of Paris in the flattened position

Tendo Achillis—This very powerful tendon measures in the adult some 4½ inches in length three quarters of an inch in breadth and a quarter of an inch in thickness

It is best divided at its narrowest part i e about an inch above its insertion

Operation—The patient may lie upon the back with the body a little rolled over towards the affected side

The foot is so turned as to lie entirely upon its outer side and a small cushion placed beneath the lower part of the leg will carry the heel off the table

The surgeon stands to the outer side of the limb in the case of both the right and the left foot

The assistant should judiciously relax the strain upon the tendon as its fibres are divided

It is obvious that if little care be taken the knife may cut through both the tendons as through tightly drawn cords, and may wound the main artery beyond

If the blood vessels should be divided a well adjusted pad of sterilized gauze must be at once applied to the spot

Singularly little trouble appears to have supervened in examples of this accident

Combined division of the tibiales tendons and certain contracted ligaments.—In severe cases of talipes varus especially those where recurrence has taken place it may be necessary to divide the internal lateral ligament those connecting the sustentaculum tali with the scaphoid and the talus and scaphoid This may be done subcutaneously but an open incision is safer and more certain

The site chosen for this combined section of ligaments and tendons is a spot a little below and in front of the tip of the inner malleous over the site of the talo scaphoid joint and in the situation of the transverse groove near the heel which is to be observed in severe talipes (Fig 118)

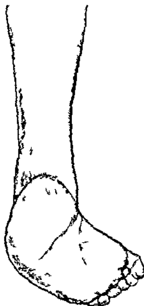


Fig 118.—Sole of the foot in talipes varus to show the creases on the skin

Operation.—The foot is so placed as fully to expose its inner border and is firmly held the positions of the tendons of the tibiales anterior and posterior are felt for and a short incision made which crosses both Each tendon is exposed and divided The ligaments mentioned above are then cut

Hamstring tendons.—These tendons are most conveniently severed just above the line of the knee-joint and on a level with the most prominent part of the condyles of the femur

Biceps.—The patient should lie as far as possible upon the face so that the popliteal space may be well exposed

The surgeon may stand upon the inner side of the limb in the case of either the right or the left tendon If he place himself to the outer side of the extremity, he will face the patient when dealing with the left leg and have his back to the patient when dealing with the right

The leg is steadied by an assistant With a sharp pointed tenotome a puncture is made directly over the tendon and the instrument is passed vertically downwards on the inner side of the tendon and is withdrawn when it has passed a little way beyond it

The blunt point is now introduced and following the same line is passed vertically between the tendon and the nerve When it has just passed beyond the tendon the blade is turned outwards the handle brought as nearly horizontal as possible and the point passed beneath the biceps until it may be felt upon the outer side

The tendon is then divided by cutting towards the skin, which is guarded with the left forefinger in the usual way During the introduction of the tenotomes and the cutting of the tendon the biceps should be kept upon the stretch As the knife is withdrawn the limb should be flexed

If care be not taken the knife may slip through the skin when the tendon gives with a snap

In the conditions for which this operation is usually performed the contracted biceps tendon is drawn away from the nerve and a wider interval than the normal separates the two structures The safest plan however, unless the nerve can be plainly felt through the skin is to make a small incision so as clearly to expose both nerve and tendon The nerve being then held aside the tendon is divided

Both in the class room and in practice we have seen a prominent and cord like ilio tibial band divided in the place of the biceps

An assistant standing by his side holds the foot Another assistant may steady the leg

The tendon having been defined is rendered a little tense but is not fully stretched The sharp tenotome is entered vertically at the inner margin of the tendon and is pushed downwards—in the present position of the foot—until it has reached the outer edge of the tendon where its point can be indistinctly felt The sharp pointed instrument is now replaced by the blunt which follows the track already made until its point can in turn be detected through the skin The instrument must be kept very close to the tendon The tendon is now put well upon the stretch and the cutting edge having been turned towards the surface the tense cord is divided with a sawing movement the left forefinger resting upon the skin over the site of the operation

The divided ends separate with a snap and unless care be taken just at the time when the tendon gives way the integuments covering it may be divided by the suddenly liberated knife

Subcutaneous tenotomy of the tendo Achillis should not be performed after the age of 5 years It should not be done in cases of spastic disease of muscles In these cases open lengthening is preferable

Lengthening the tendo Achillis —Especially in adults this measure is advocated in preference to simple section It necessitates exposure of the tendon through a longitudinal wound made at one side of the tendo Achillis to which two short transverse cuts are made above and below The flap thus marked out is dissected off the tendon and held aside The tendon is then split transversely at the upper end and the splitting continued to near the os calcis where the front portion is cut across This leaves two free portions—one above the other below The foot is flexed so that all deformity is overcome and the two portions are sutured together with fine silk

The method is illustrated in Fig 125 (p 267) It has largely replaced simple tenotomy

Hamstring tendons—These tendons are most con veniently severed just above the line of the knee-joint, and on a level with the most prominent part of the condyles of the femur

Biceps—The patient should lie as far as possible upon the face so that the popliteal space may be well exposed

The surgeon may stand upon the inner side of the limb in the case of either the right or the left tendon If he place himself to the outer side of the extremity, he will face the patient when dealing with the left leg and have his back to the patient when dealing with the right

The leg is steadied by an assistant With a sharp pointed tenotome a puncture is made directly over the tendon and the instrument is passed vertically downwards on the inner side of the tendon and is withdrawn when it has passed a little way beyond it

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Both in the class room and in practice we have seen a prominent and cord like ilio tibial band divided in the place of the biceps

In some thin and muscular subjects the lower portion of this fascial band may feel very tendon like

Numerous contracted bands of fascia may come into view after tenotomy of the biceps for contracted knee Some may need division They are however better left alone as they usually yield under extension, and in dealing with them by tenotomy unexpected vessels may be wounded

Semitendinosus and *semimembranosus* —The same observations as in the case of the biceps apply generally to these

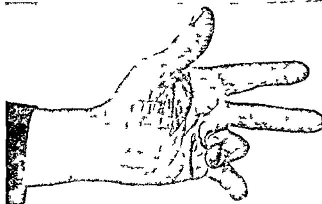


Fig 119 —Dupuytren s contraction

tendons They are most conveniently divided exactly opposite the spot elected for tenotomy of the biceps

The tenotome is introduced upon the outer side of the tendon and is pas ed beneath it The steps of the little operation need not be repeated

Dupuytren's contraction —The exact anatomy of the palmar fascia should be borne in mind and especially the manner in which the digital processes of the fascia are disposed of and the connexions of the ultimate slips of the fascia with the integument of the fingers It will be remembered

that each division of the palmar fascia sends five slips 1 A central one to the sheath of the flexor tendons 2 One on either side to the skin at the cleft of the fingers 3 One to the superficial transverse ligament on either side In Dupuytren's contraction all these may be hypertrophied (Fig 119)

Open excision of the contracted bands (Fig 120) —The patient's hand must be sedulously cleaned with alcoholic solution of carbolic acid etc special attention being paid to the

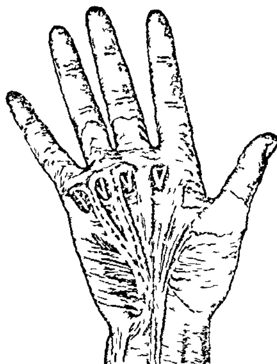


Fig 120 —Dissection of palmar fascia
The two inner bands are the ones concerned in Dupuytren's contraction The dotted lines over these indicate the incisions for their removal

deep furrows caused by the contraction in which dirt is apt to collect and lie concealed An Esmarch's tourniquet is convenient and should be applied above the wrist The hand being

held by an assistant with the palm upwards and the fingers extended as far as possible the surgeon makes a longitudinal incision directly over the main bands of fascia and if necessary adds two short transverse cuts at either end When both little and ring finger are affected it is best to make two separate linear incisions, as shown in Fig 120 Some surgeons prefer to use a curved incision on the inner side of the hand and to reflect the flap outwards but its dissection from the adherent bands of fascia is a difficult measure We will presume that no flap is raised but the incision made directly over the contracted band The skin is carefully reflected on either side as it is very easy to buttonhole The fascial band projects forwards from the digital vessels and nerves and with due care it is easy to avoid dividing these at the same time as the fascia The band of the latter having been cut through at the upper end of the incision where it is a single tough cord is then drawn out and with its various prolongations again divided below It is at this point that the digital vessels and nerves are in most danger From 1 to 2 inches of the fascial band is removed and the more thoroughly its divisions are dissected out the better will be the result Indeed it is well to dissect away all fascial tissue exposed which feels distinctly hard to the touch After the tourniquet has been removed and bleeding stopped the wounds are sewn up with fine silkworm gut The incisions are apt to gape a little and sutures should not be applied where they cause too much tension If necessary a split skin graft may be applied to bridge a deficit

The fingers affected are put up on a splint in the extended position The wounds will probably be healed in a week but before this time the phalangeal joints should be flexed every day so as to prevent their becoming stiff The use of some kind of splint to keep the fingers extended at night time for long afterwards is advised by some surgeons but this is irksome and does not prevent recurrence of the contraction

Division of the sterno-mastoid muscle—The sterno mastoid muscle is encased in the cervical fascia and to obtain the best result in operating for wry neck it is essen

tial to divide not only the muscle but its contracted sheath The sternal portion of the muscle usually appears to be more contracted than the clavicular but it will almost always be found necessary to divide both The division should be carried out a short distance above the clavicle, and not close to that bone and it should be done by the open method for by this procedure alone is it possible to divide the muscle and fascia completely without risk of injury to the veins

Operation —A general anæsthetic having been given the head and shoulders are well raised the surgeon standing on the same side as that of the contracted muscle A curved incision which crosses the contracted muscle (as shown in Fig 121) a short distance above the clavicle, is made, and the

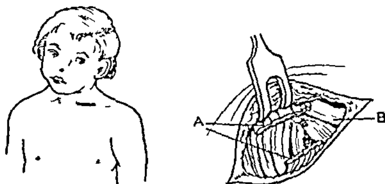


Fig 122.—Torticollis left the incision for open tenotomy right the sterno mastoid divided and the deep fascia cut
A Severed sterno mastoid B Omo hyoid

small flap of skin and superficial fascia is retracted The assistant who steadies the patient s head makes the con tracted muscle as tense as possible, whilst the surgeon steadily divides first the sternal and then the clavicular portions and the fascial band The division is done gradually from before backwards with a blunt pointed tenotome or fine scalpel and the large veins are looked for and carefully avoided The posterior part of the sheath will usually be found to require division or stretching The small wound is

held by an assistant with the palm upwards and the fingers extended as far as possible the surgeon makes a longitudinal incision directly over the main bands of fascia and if neces sary adds two short transverse cuts at either end When both little and ring finger are affected it is best to make two separate linear incisions as shown in Fig 120 Some surgeons prefer to use a curved incision on the inner side of the hand and to reflect the flap outwards but its dissection from the adherent bands of fascia is a difficult measure We will presume that no flap is raised, but the incision made directly over the contracted band The skin is carefully reflected on either side as it is very easy to buttonhole The fascial band projects forwards from the digital vessels and nerves and with due care it is easy to avoid dividing these at the same time as the fascia The band of the latter having been cut through at the upper end of the incision where it is a single tough cord is then drawn out and with its various prolongations again divided below It is at this point that the digital vessels and nerves are in most danger From 1 to 2 inches of the fascial band is removed and the more thoroughly its divisions are dissected out the better will be the result Indeed it is well to dissect away all fascial tissue exposed which feels distinctly hard to the touch After the tourniquet has been removed and bleeding stopped the wounds are sewn up with fine silkworm gut The incisions are apt to gape a little and sutures should not be applied where they cause too much tension If necessary a split skin graft may be applied to bridge a deficit

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CHAPTER II

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In this chapter are considered the operations undertaken for both the primary and secondary suture of cut tendons methods of tendon grafting and tendon transplantation, and the indications for and means of lengthening and shortening tendons.

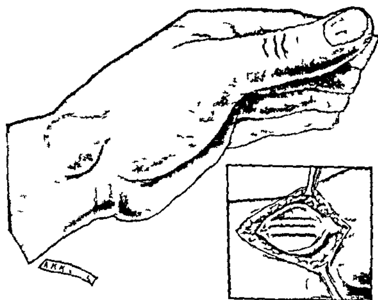


Fig 122 —Operation for stenosing teno vaginitis

Stenosing teno vaginitis is found in relation to the short extensors of the thumb and causes a swelling over the styloid process of the radius (Fig 122)

closed with a few of the finest ("ophthalmic") silkworm gut sutures and dressed with gauze and collodion or some other light and dry dressing. By this deliberate and open division the risk of recurrence of the deformity is avoided and the necessity for wearing irksome apparatus obviated.

For the next few months after operation the child should be kept under observation, and daily exercises carried out to stretch the muscles of the neck and prevent tendency to contraction. Some surgeons fix the neck (in the over-corrected position) by some form of apparatus which must be worn for several months.

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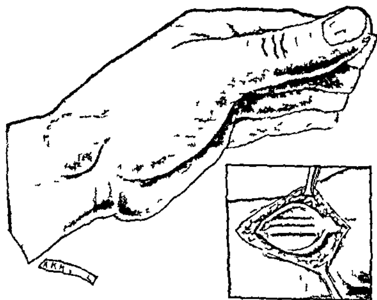


Fig 122 —Operation for stenosing teno vaginitis

Stenosing teno vaginitis is found in relation to the short extensors of the thumb and causes a swelling over the styloid process of the radius (Fig 122)

Operation consists in incising the swelling and excising the fibrous sheath over the tendons (Fig 122)

Tendon-suture—In all cases of tendons divided in an open wound attempts must be made to secure an accurate apposition of the ends by means of a primary operation In most cases where the condition has not been diagnosed at the time of injury or where the conditions are such that primary suture cannot be accomplished a secondary operation will be required owing to the amount of disability caused by the loss of function of the part to which the tendon is united In the cases in which a subcutaneous rupture of the tendon has occurred suturing will be the best or only means of securing good union between the divided ends

Primary suture of cut tendons—Injuries involving division of tendons usually occur in the forearm in the neighbourhood of the wrist As is to be expected they are more common in those whose duties include heavy and dirty work The wounds are therefore often lacerated and septic Tendons are composed of fibrous avascular tissue and depend almost wholly upon the sheath for their nutrition For this reason it is essential that the wound is made aseptic and kept dry for if these conditions are not fulfilled failure of union is very likely to occur Special precautions which are described below must be undertaken to attain these results

The patient having been anæsthetized and the wound plugged with aseptic gauze the structures around are shaved and thoroughly cleansed Any foreign bodies and lacerated tissues which are visibly dead are now removed and the skin adjacent to the wound is cleansed with an ethereal solution of soap and an alcoholic solution of biniodide of mercury The wound itself is thoroughly washed out with saline solution or boiled water and cleansed with the aid of sterilized gauze and swabs An assistant then applies a tourniquet well above the site of the injury

The tendons are now isolated and identified *In the* majority of cases the wound is transverse and to aid in the identification of the tendons a longitudinal incision will probably be found necessary This incision will of course be

prolonged proximally, i e towards the elbow joint or the proximal ends of the tendons retract owing to contraction of the muscle bellies To keep the identified tendons separate it will be found most useful to pass a long suture through any two corresponding ends The sutures are then loosely knotted until all the tendons are identified and the surgeon is prepared to approximate their ends

About an eighth of an inch is now cut off the ends of each tendon so that no dead tissue is left behind All vessels having been ligatured the ends are finally sutured Fine thread or silk are probably best since they are reliable and easily knotted Stainless steel wire is also a valuable suture material because it results in a minimal fibrous tissue reaction Sizes No 28–32 wire should be used and kinking must be avoided as this weakens the wire As the fibres of the tendon are arranged parallel to its long axis, the sutures have a tendency to cut out Many methods have been adopted to overcome this tendency The method known as Le Dentu s suture will in the majority of cases be found quite satisfactory Here a tension suture is passed through both ends, traversing the whole thickness of the tendon half an inch from its extremity Good apposition is obtained by the use of approximation sutures which pass only partially through the substance of the tendon and close to the extremity The tourniquet is then removed, and any bleeding points which may have previously escaped notice are firmly secured A small tube or gauze drain is inserted and the skin united with silk worm

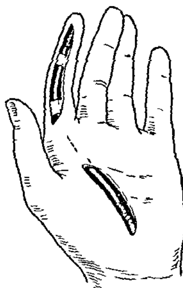


Fig 123 —Diagram showing Bunnell s tendon suture

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3 Where only one end can be found

In the first group the operation will be continued on the lines laid down in the preceding section the ends being carefully sutured together The after treatment should be so conducted as to prevent adhesions, but should not be sufficiently vigorous to separate the newly joined ends

In the second group some means of tendon lengthening or grafting must be undertaken as described below

In the third group a means of tendon anastomosis may be utilized (p 268)

Tendon lengthening.—It may be necessary to lengthen tendons, either because the ends have become separated by

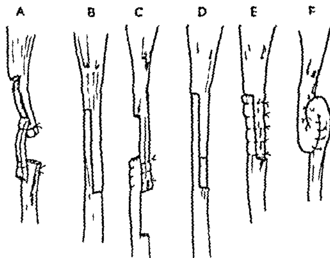


Fig 124 —Operations for tendon lengthening (Figs A B and C), and tendon shortening (Figs D E and F)

a considerable distance, as in many cases of secondary suture and in cases where it has been necessary to remove a portion of the tendon for pathological conditions of or involving it or because the muscle and tendon have become contracted so that full extension of the part to which the tendon is

gut sutures The wound is dressed with gauze and put up on a curved splint so as fully to relax the divided tendons The drain may be removed at the end of forty eight hours

Bunnell has elaborated a technique of suture at a distance The insertion of the wire in the tendon and across the gaps in the tendon is made as described above but the free ends are not tied on the tendon They are brought out through the skin and tied over a button A second wire suture is passed through the proximal loop of the first suture and is brought out through the skin proximally and anchored After three weeks immobilization the button holding the first suture is removed and the first suture (the one which holds the tendon) is pulled out by means of the second suture In this way no foreign material is left within the tendon

Tendon-grafting —This procedure is indicated when a length of tendon is missing or fibrotic and adherent It is particularly used to avoid suturing the digital flexor tendons within their flexor carpal sheaths In the latter case it has been found advisable to retain the deep tendon only, the superficial tendon may be used as the graft or palmaris longus if present Best results are obtained if the suture at a distance technique of Bunnell using stainless steel wire is employed

Secondary suture of cut tendons—In this case where some interval has elapsed between the time of the division and that at which treatment is sought an operation is undertaken on lines similar to the above Here difficulties arise in that infection may recrudesce the tendons may be difficult to find firmly adherent in their sheaths and difficult to approximate A guarded prognosis should be given Whilst the difficulties in maintaining asepsis will be less there will be an increased difficulty in identifying the tendons in freeing them from adhesions and in approximating their ends Thus three conditions will have to be considered —

1 Where the ends having been freed and identified can be approximated without undue tension

2 Where both ends can be freed but cannot be easily approximated

central bar of the Z runs vertically down and is made half an inch longer than the amount by which it is desired to lengthen the tendon The two pieces of tendon are now slid down and the ends sutured with fine silk It is obvious that by this method the tendon is reduced to one half of its original thickness and strength, but ultimately it becomes as strong as before

This method of tendon lengthening finds greater application in cases of deformities—club feet spastic paralysis and the

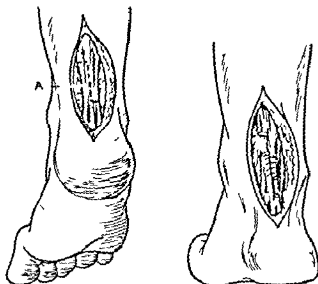


Fig 125 —Open lengthening of the tendo Achillis left the equinus deformity and the incision (A) in the tendon right suturing the lengthened tendon

like—than in cases of tendon injury (Fig 125) It is termed **open tendon lengthening** in contra distinction to lengthening by tenotomy Open lengthening is especially preferred to tenotomy in cases of spastic disease as here over lengthening is very likely to occur In the open operation control is more exact

attached is no longer possible Only a few of the many ingenious methods can be described here

(a) *Where the ends are separated by a considerable distance* —The two ends having been bared a double suture is passed through the proximal portion near its extremity A flap is turned down from this piece the flap being saved from complete separation by the suture already passed This flap is utilized to bridge across intervening space and is sutured to the distal end (Fig 124 A)

In certain cases where the division of the tendon is close to the insertion the gap may be bridged over by separating with a saw or chisel the bony point of insertion and fixing it to the main portion of the bone at a somewhat higher level This has been done in the case of division of the tendo Achillis the ligamentum patellæ etc It is obvious that this method is of very limited application as it only compensates for a small amount of shortening

When the tendons are so small that a flap would be likely to slough and the division is too high up to allow of osteotomy the gap may be bridged across by strands of suture which probably act as a scaffolding around which firm fibrous tissue is laid down Grafts taken from the same or other tendons have been utilized in a similar manner but it is more satisfactory to use dried tendon for the purpose By attaching one or more strands of the latter to the two ends any gap can be well filled the tendon becomes organized and part of the living tissues Two points require attention if this grafting with dried tendon is to succeed first to remove any strong antiseptic from the tendon before it is inserted (by soaking in cold sterile water) and secondly to give the part complete rest on a splint in a favourable position for a few weeks after the operation Strips of fascia lata taken from the thigh of the patient have also been employed with success

(b) *Where the tendon is in continuity but is contracted*— Here the method illustrated in Fig 124 B C is the most serviceable and gives the firmest union The tendon having been laid bare a Z shaped incision is made through it the

one, a single incision is made, if separated by any distance two smaller ones are preferable one over each tendon and these are laid bare The three following methods are those most commonly adopted —

1 The healthy tendon is completely divided and the

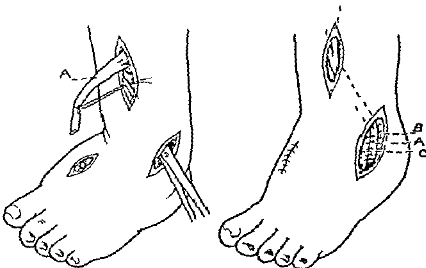


Fig 127.—Tendon transplantation the tibialis anticus (A) is being transplanted to the outer side of the foot B peroneus longus C peroneus brevis

Note —The three incisions on the tendon must be thoroughly freed The tendon is inserted into the cuboid which has been drilled for it and is also stitched to the paralysed tendons

proximal end is united to the paralysed tendon preferably by suturing it into a buttonhole prepared in the latter Care should be taken to suture the tendon as it passes through the buttonhole and distally to the affected tendon (Fig 127) This method is the least recommended of the three and should never be done when the other methods are possible The paralysed distal tendon goes on stretching and thus spoils the result in numerous cases

Tendon-anastomosis.—This is chiefly required in cases of cut tendon, where a secondary operation having been performed the distal end of the tendon can alone be found, the proximal end being so retracted that it is difficult or even impossible to isolate it.

The distal end having been found is freshened and is then cut obliquely. A neighbouring tendon which has been selected for anastomosis is now isolated for a short distance and a small vertical incision is then made through the middle of its length. The small buttonhole thus made is opened up and the end of the cut tendon inserted: sutures of thin catgut are now passed to hold the two portions in apposition. Instead of this a small slip may be cut from the healthy tendon turned outwards and joined end to end with the cut tendon which in this case is cut square and not trimmed to a point as in the last case (Schwartz) (Fig. 126.)

Tendon-transplantation.—This operation has chiefly been undertaken in cases of paralysis of individual muscles such as occurs after anterior poliomyelitis and this means of treatment has now become a large branch of orthopædic surgery. A brief description of one or two of the principal methods adopted can alone be given.

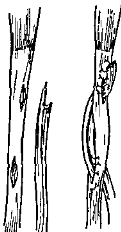


Fig. 126.—A method of securing sound tendon anastomosis.

In most cases the tendon to be transplanted should belong, if possible, to the same group as the paralysed one and should act parallel to it. In some cases however it is better to transplant an opponent of the paralysed muscle, as by this means the deformity is more likely to be overcome.

If the tendon to be transplanted is in close proximity to the paralysed

one, a single incision is made, if separated by any distance two smaller ones are preferable one over each tendon and these are laid bare The three following methods are those most commonly adopted —

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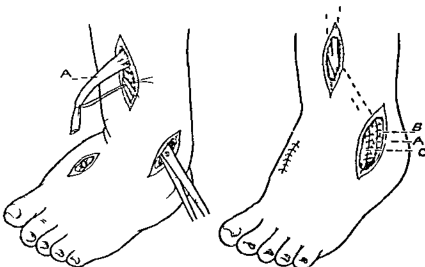


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The distal end, having been found is freshened and is then cut obliquely A neighbouring tendon which has been selected for anastomosis is now isolated for a short distance and a small vertical incision is then made through the middle of its length The small buttonhole thus made is opened up and the end of the cut tendon inserted, sutures of thin catgut are now passed to hold the two portions in apposition Instead of this a small slip may be cut from the healthy tendon, turned outwards and joined end to end with the cut tendon which in this case is cut square and not trimmed to a point as in the last case (Schwartz) (Fig 126)

Tendon-transplantation.—This operation has chiefly been undertaken in cases of paralysis of individual muscles such as occurs after anterior poliomyelitis and this means of treatment has now become a large branch of orthopædic surgery A brief description of one or two of the principal methods adopted can alone be given

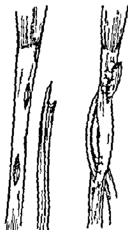


Fig 126.—A method of securing sound tendon-anastomosis

In most cases the tendon to be transplanted should belong if possible to the same group as the paralysed one and should act parallel to it In some cases however it is better to transplant an opponent of the paralysed muscle as by this means the deformity is more likely to be overcome

If the tendon to be transplanted is in close proximity to the paralysed

When tendon transplantation is performed in cases of paralysis from poliomyelitis two precautions must be observed (a) first correct any deformed position of the foot, (b) see that the correction is not overdone and a fresh deformity produced

Tendon transplantation has perhaps met with the greatest success in cases of radial nerve paralysis and consequent loss of extension of wrist and fingers Here the pronator teres is detached from its radial insertion and attached to the radial extensors of the carpus, the palmaris longus to the extensors of the thumb, the flexor carpi radialis to the common extensor of the fingers, etc With subsequent "muscular education' a wonderful improvement in the usefulness of the hand is thus gained

The long extensor tendon of the thumb is sometimes ruptured as it passes across callus around Lister's tubercle in Colles fracture The flexed terminal segment of the thumb is a great disability The condition may be corrected by suturing the proximal end of the extensor carpi radialis longus or brevis tendon into the distal end of the pollicis longus suitably trimmed The wrist is afterwards immobilized in plaster for six weeks with the thumb in full extension

Tendon-shortening may be undertaken in some cases resulting from old anterior poliomyelitis where deformity is present but it is essential, before undertaking the operation that active tissue be found in the affected muscle—a point which may be best determined by a careful investigation of the electrical reactions If no muscular tissue be present such an operation is of necessity bound to fail and although the deformity may at the time be corrected the tendon will again stretch as soon as the limb is used For such cases some form of tendon anastomosis as described above is indicated

The method which gives the firmest union is an adaptation of Anderson's method of tendon lengthening The tendon having been laid bare a Z shaped incision is made through it the central end of the incision running vertically down the middle of the tendon The pieces being separated, as much

2 A hole may be drilled through the bone at the point of action of the new tendon where it is threaded through and attached distally by means of a suture to the periosteum If sufficient length is available the tendon is pa_ ed through the tunnel and stitched back on itself (Fig 128)

3 Part of the point of insertion may be moved with the

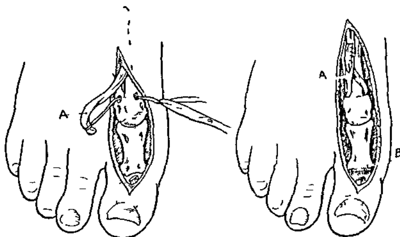


Fig 128 —Transplantation of the tendon of the extensor longus hallucis for pes cavus

Left detachment of the tendon (A) and drilling of the neck of the meta tarsus right suture of the tendon on itself (A) and arthrodesis of the terminal interphalangeal joint (B)

tendon and fixed into a bed prepared for it in the bone at its new point of action

In uniting the two ends silk sutures may be used and the healthy tendon hould be stretched but this must not be overdone the stretching must be kept well within the bounds of the elasticity of the muscle The incision is sutured and the limb now placed in the fully corrected position so as to relieve tension and kept immobilized in this position for from four to six weeks after which massage gentle passive movements and faradism should be employed daily

PART VI—PLASTIC SURGERY

CHAPTER I

OPERATIONS FOR HARE LIP

SINGLE HARE LIP THE USUAL OPERATION

Special instruments required.—A fine, narrow sharp pointed scalpel or small tenotome (for the less simple methods a slender double edged knife is useful), slender bladed dissecting forceps with toothed points, small sharp pointed scissors curved on the flat a pair of clamps for the lips (these are useful but not essential) a gag and tongue forceps may occasionally be useful small fine sponges

Operation (Fig 129)—The operation is not performed until the infant is 2 or 3 months old or alternatively, until it weighs 10 pounds It is wrapped up in a towel or sheet, so that the head alone projects In this mummy like guise it is easily handled and the movements of its limbs are restrained

The patient lies supine with the head well raised and supported upon a firm pillow

The surgeon faces the patient or stands to the right hand side An assistant places himself behind the child and steadies the head The anæsthetist will stand upon the left of the table

First step—Grasping the upper lip the surgeon proceeds to separate it—upon each side of the gap—from the maxilla This can best be effected by means of a small sharp pointed scalpel combined with a small elevator or the blunt ' dissector ' The scalpel must be kept close to the bone to avoid

is removed from each end as it is desired to shorten the tendon by The two portions are now sutured together (Fig 124 D)

Removal of a portion of the whole thickness of the tendon followed by simple end to end suture is but rarely successful Union is enacted by simple fibrous tissue which is very likely to stretch and allow the tendon again to lengthen

so that the two raw surfaces are brought together The approximation must be exact The margins are then united by means of ophthalmic silkworm gut sutures carried on fine, curved cutting needles

The first suture should involve the middle of the lip, the next the lower portion and the third the segment near the nostril These are the three main sutures They should include the whole thickness of the lip excluding the mucous membrane only and the first or median suture, if properly introduced should command the labial arteries when it is finally drawn tight These vessels may however, be secured by fine ligatures after relaxing the compression clamps In any case these clamps are removed when the sutures are in place

After the surgeon is satisfied that the best possible adjustment has been obtained (and one or more of the needles may have to be reintroduced before it is obtained) the sutures are drawn through tied in the usual way and cut moderately long to facilitate their removal on the seventh day

The three stitches are introduced about one third of an inch from each side of the cleft

Two three or more sutures are now inserted at the free margin of the new lip especially upon its inner or alveolar aspect These are composed of the finest silkworm gut, and are passed by means of slender curved needles held in a needle holder

Some of these fine stitches may be required along the main wound and one will usually be needed for the margin of the nostril

The wound having been well dried with small pieces of gauze the surface is dusted with boric acid and covered with a few layers of soft gauze kept in place by flexile collodion This helps to keep the suture line dry, but a good result may also be obtained by dispensing with any form of dressing and merely dusting on some boric acid powder

Note —During the operation it is important to attend carefully to the red margin of the lip when united the two parts should form one even line with a slight projection downwards at the site of the original cleft Unfortunately this

bleeding It may be necessary to detach one ala of the nose from the maxilla In any case the detachment should be sufficiently free to allow the margins of the cleft to come together readily and without the least tension

So far there will be only slight bleeding easily controlled by pressure of a small sponge held in a holder But during the next step—paring the lip itself—there will be considerable hæmorrhage unless preliminary measures are taken to prevent it The best way is to adjust a rectangular compression clamp on either side well wide of the cleft Each clamp grasps the whole thickness of the lip it is secured by an adjustable catch Another method is for the assistant s fingers and thumb to take the place of the clamp on either side but this is far less convenient, as they get in the way of the operator A third method is pressure on both facial arteries as they mount over the lower jaw



Fig 129 —Operation for single hare lip

Second step —The edges of the cleft are now pared The lip on one side having been made tense is transfixed in its whole thickness from before backwards by the narrow scalpel The point is entered just above the lower angle of the flap and the edge being directed upwards the knife is made to cut towards the upper angle of the gap to follow that angle and finally to descend upon the other side The knife is then withdrawn and is not allowed to cut its way out The piece isolated by paring will still be attached to the lip at both ends and its detachment may be left until some of the sutures have been introduced and until the amount of tissue required for the formation of a good free margin to the new lip has been ascertained

In any case the paring must be freely liberally and evenly carried out The raw surface should be as wide as possible especially below

Third step —The gap is now closed The assistant who holds the head presses the cheeks together with his fingers

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Third step—The gap is now closed The assistant who holds the head presses the cheeks together with his fingers

the incisor teeth temporary and permanent, in the upper jaw, but also inevitably leads to a flattened or sunk upper lip when the patient grows up There are few deformities of the face more conspicuous than this abnormal depression.

Very usually the bending back of the bone is resisted by the cartilaginous vomer of children, and the elasticity of that structure causes the fragment to be again protruded when the pressure is removed.

In such a case a portion of the vomer must be excised subperiosteally An incision is made along the free border of the septum, leaving its arteries intact the periosteum and mucous membrane are then elevated on either side and a triangular segment is excised from the vomer The os incisivum can now be pushed into place, and may be retained, if needed by one or more sutures

The bleeding in this operation is apt to be free unless the subperiosteal method be closely adhered to

point is usually forgotten, and the patient grows up with a slight but disfiguring notch in the lip, which perpetually calls attention to the site of operation

Double Hare Lip

The operation required in cases of double hare lip is of the same character as that already described

In many instances the defect is more easily remedied when it is double than when merely a single gap exists In the most favourable forms of double hare lip the sides of the cleft are symmetrical and are moreover more nearly parallel than is the case in single hare lip



Fig 130 —Operation for double hare lip

A malplaced premaxillary bone is the most troublesome complication met with in dealing with this deformity

The skin over the premaxillary bone is freed from its deep attachments behind and its edges are pared so that it receives a U or V shaped outline The margins of the lip on each side are then pared in the manner already described (p 274) The portions of the lip may or may not need to be freed from their attachments (Fig 130) The raw edges are finally united with silkworm gut sutures Owing to the small size and the shape of the central piece the resulting wound is more or less Y shaped

In order to avoid the notching which not infrequently occurs in the median line when cicatrization has taken place after this operation, thick flaps with square ends may be cut from each margin of the main cleft These flaps have their attached ends downwards They are united to the raw margins of the central segment above and to one another along what is now the new margin of the lip The segments of the lip will need to be freed from their deep connexions on each side of the cleft

When the premaxillary bone projects strongly forwards its removal was formerly advised but this should never be done Removal of this bone not only means loss of all

venience right and left handed elevators long handled sharp pointed scissors both straight and curved on the flat and a long handled paring knife will be required Small fully curved needles and needle holders and numerous small sterilized sponges on holders are necessary

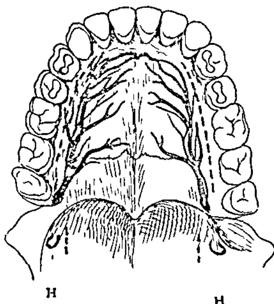


Fig 131 —The palatine arteries in relation to the operation for cleft palate

The broken line on either side between the gum and the palatine artery and nerve shows where the incision should be made in order to displace these inwards uninjured in the flaps H H Hamular processes A broken line to the inner side of each hamular process indicates how the tensor palati may be divided so as to relieve tension

Technique—The tongue is drawn forwards out of the mouth by means of a strong silkworm gut stitch and the Smith s gag placed in position Two lateral incisions placed ⅛ of an inch from the inner alveolar margin and extending from the lateral incisor teeth backwards to the anterior pillar of the fauces are made down to the bone (Fig 131)

CHAPTER II

OPERATIONS FOR CLEFT PALATE

Any operation for the treatment of cleft palate if it is to be successful must guarantee two things (1) a soft palate which is mobile (2) a soft palate which when elevated makes contact with the posterior naso pharyngeal wall and completely separates the naso pharynx from the mouth The successful closure of the cleft in the hard palate is of secondary importance as this can always be effected by means of an obturator

The best operation and one which can always be adapted to any type of cleft palate case is that devised by Langenbeck or some modification thereof and this operation will be described

Age —The most suitable age for this operation is two years By this time the muco periosteum of the soft palate is sufficiently thick to afford a reasonable chance of satis factory union the mouth is large enough to permit easy access and the teeth have erupted so that the operation can have no detrimental effect upon them

Pre operative condition —The child must be in good health and gaining in weight There must be no recent history of cold bronchitis or otitis media and all the teeth must be healthy If the tonsils and adenoids are infected they are removed one month before the cleft palate operation is performed Careful hygiene of the mouth is carried out for three or four days before operation

The Langenbeck operation —The child lies on its back with the head hyperextended over the end of the table and resting upon the surgeon s knees as he sits behind the head Anæsthesia is maintained by intrapharyngeal in sufflation of ether the gum elastic catheter having been passed through the nostril

Instruments —A gag of the Smith type is a great con

inserted in order to approximate accurately the mucous edges, and these are continued to as high a level as possible

Post-operative treatment—Padded splints are applied to the arms to prevent the child putting its fingers to its mouth Chloral and bromide should be given 4 hourly for a few days to prevent restlessness For five days after the operation only sterilized fluid feeds are given, and milk is best avoided until the fourth day After 48 hours the mouth should be gently irrigated with warm sterile water Stitches are removed under anæsthetic on the tenth day, with the exception of those on the posterior surface of the uvula which may be permitted to slough out

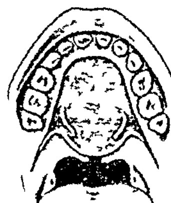


Fig 134.—Wardill's operation Detachment of the muco periosteum with its blood supply

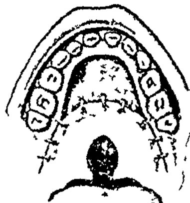


Fig 135 —Wardill's operation The whole soft palate is displaced backwards

It is essential that the child shall attend a speech clinic if a good functional result is to be obtained

The causes of failure are tension sepsis and lack of blood supply

Gillies' operation.—This is an alternative method the object being to produce a long movable soft palate, leaving a gap in the hard palate which may be closed by an

The muco periosteum is raised from the inferior surface of the hard palate by means of the right-angled elevators and this is continued until it is fully separated on both sides of the median cleft The margins of the cleft are now pared with the paring knife, an operation best commenced at the junction of hard and soft palate while the uvula is held tense with dissecting forceps The soft palate is then thoroughly freed from the posterior margin of the hard palate by means of long handled, slightly-curved sharp pointed scissors When this has been thoroughly effected

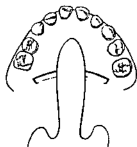


Fig 132 —Incision of mucous membrane and hard palate

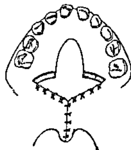


Fig 133 —Suture of the two halves of the soft palate in this lengthened position and of the two mucous flaps to cover the anterior raw edge of the new palate to prevent retraction

the edges of the cleft are easily approximated and stitches may be inserted without tension These stitches are of horse hair or fine silkworm gut and the first is inserted at the junction of hard and soft palates The soft palate may be sutured with horse hair and the cleft in the hard palate covered by the approximation of the muco periosteum now thoroughly detached from the bone and for this purpose silkworm gut sutures are preferable The stitch in the tip of the uvula is cut long and used as a retractor on the soft palate which is tilted forwards thus bringing the posterior surface into view Interrupted horse hair sutures are now

inserted in order to approximate accurately the mucous edges and these are continued to as high a level as possible

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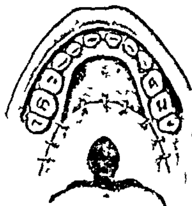


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obturator The operation is illustrated in Figs 132 133 Most satisfactory speech results are obtained by this method, even when the soft palate has little muscular tissue in it

Wardill's Operation —Wardill, formerly of Newcastle upon Tyne has pointed out that closure of the naso pharyngeal valve which is essential for normal phonation is dependent not only on a freely mobile soft palate which can be approximated to the posterior pharyngeal wall but also to a pharyngeal element This is the contraction of some of the fibres of the superior constrictor which produce a distinct ridge which, in conjunction with the palate completely shuts off the naso pharynx

In cleft palate the naso pharynx is sometimes unduly deep and wide and this may be still further widened by fibrosis produced in the velum after plastic operations resulting in a poor functional result

Wardill s operation consists in moving the soft tissues of the entire palate backwards (Fig 134) allowing the exposed hard palate to granulate but enabling the soft palate to be approximated to the posterior pharyngeal wall (Fig 135) The cleft in the soft palate is then pared and sutured

PART VII —OPERATIONS ON THE FACE, THROAT AND NECK

CHAPTER I

TRACHEOTOMY AND LARYNGOTOMY

1 Drainage of Maxillary Sinus

It must always be remembered that the orifice of the antrum into the middle meatus is an inch above the antral floor (Fig 136), and hence the natural drainage is defective The antral cavity can be washed out from the nose, the inner wall being punctured through the inferior meatus after efficient cocainization warm sterile salt solution being employed (Fig 136) It is important to make certain that the point of the cannula is actually within the antral cavity before commencing lavage as it is possible that it is still in the nasal cavity or has crossed the antral cavity and may be (a) in the orbital cavity or (b) under the cheek in the canine fossa or (c) in the pterygoid region

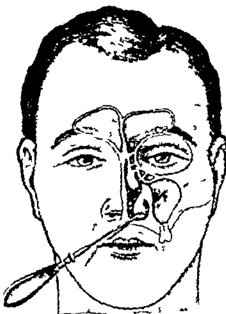


Fig 136 —The frontal ethmoidal and maxillary sinuses shown diagrammatically A trocar and cannula are in position for lavage of maxillary sinus

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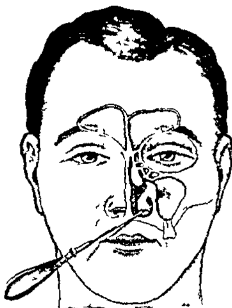


Fig. 136.—The frontal, ethmoidal and maxillary sinuses shown diagrammatically. A trocar and cannula are in position for lavage of maxillary sinus.

For cases of chronic suppuration in the antrum an intra nasal operation will usually suffice to be effective the anterior part of the inner (nasal) wall of the antrum under cover of the inferior turbinal must be removed to allow of dependent drainage and lavage of the antrum

Sometimes there is a large accumulation of polypoid tissue within the antrum To remove it the surgeon must make an opening for inspection by incising the mucous membrane and periosteum over the canine fossa after retracting the upper lip He then makes an opening through the anterior bony wall (Caldwell Luc operation) Effective removal of hyperplastic mucosa can then be performed under direct vision, but this buccal opening is allowed to close at the end of the operation An opening into the nasal fossa is then made through the inferior meatus as in intranasal antrostomy

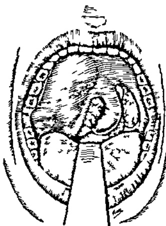


Fig 137 —Diagram to indicate the situation to open a peritonsillar abscess, viz on a line drawn from the base of the uvula to the last molar tooth but nearer the uvula

2 Peritonsillar Abscess

The area of the peritonsillar abscess should be painted with 5 per cent solution of guaiacol in glycerine several times prior to the opening of the abscess this application acts both as an antiseptic and as a local anæsthetic

Pus is evacuated by the use of sinus forceps after incision of the superficial layers with a guarded scalpel this can be conveniently made by winding a thin strip of adhesive plaster around the blade The surface may be anæsthetized with equal parts of cocaine solution (10 per cent) and adrenalin applied on a wool swab Fig 137 indicates the point of

election at which to open a peritonsillar abscess viz a little internal to a point midway between the base of the uvula and the last upper molar tooth The opening is suitably enlarged downwards towards the middle line It is essential not to go too deep or too far outwards so as not to injure the superior constrictor or to open through the deep fascia

If done under general anæsthesia it is a safe measure to seat the patient in a dental chair and give a short nitrous oxide anæsthetic

3 Tracheotomy

The operation is said to be high or low ' according as the trachea is opened above or below the isthmus of the thyroid body In the adult the isthmus crosses the second and third rings of the trachea and sometimes even the fourth In the child the isthmus is narrow and is usually somewhat higher up It may even lie on the crico tracheal membrane

Instruments required—Scalpels, several pairs of Wells s forceps the more slender in make the better, dressing forceps and two pairs of fine toothed forceps sharp hook blunt hook scissors needles, tracheotomy tubes and tapes To these may be added a gag and tongue forceps small wound retractors and feathers to clear the tube when first introduced

The finger and thumb of the operator s left hand serve to retract the soft parts during the first step and often suffice until the hook is introduced If however other retractors are used two loops of suture each catching one edge of the wound get less in the way than metal instruments The latter, unless held by a skilled assistant may prove worse than useless in the operation

Special angular dilating forceps are sometimes used to facilitate the introduction of the tube These should be discarded their action differs from that of other hinged instruments in that the jaws open when the handles are approximated, and they do little but create confusion at a critical moment A sterilized hair pin or a closed safety pin may be used as a dilator in an emergency As described

later the serrated forceps alone are required in most cases to open the tracheal wound for the tube

A good tracheotomy tube should be of simple construction should be easy to introduce should be as large as the diameter of the trachea will admit should lie exactly in the long axis of the windpipe should have a movable shield so that it is disturbed as little as possible, and the inner cannula should be capable of being easily inserted and removed The tube should not be strongly curved or its end will irritate the tracheal wall Parker s angular tube fits best of all

Position of the patient—The child is enveloped in a thin mackintosh sheet and is placed close to the right edge of the table The surgeon stands by the same side of the table The neck is supported on a firm sand bag of suitable size or some similar firm pillow An excellent substitute always at hand is a cylindrical bottle wrapped in a soft towel When the child is ready the head should be drawn well over the upper end of the table so that the vertex is turned nearly towards the ground

The sand bag will be placed close to the upper edge of the table and over it the child's head is extended in this extreme manner

This position renders the structures on the front of the neck tense steadies the trachea draws as much of that tube up into the neck as is possible and brings it somewhat nearer to the surface The superficial veins are moreover a little emptied of their blood by this attitude of over extension

An assistant stands opposite the surgeon and it is his duty to hold the head steady fully extended and with the point of the chin and the supra sternal notch in the same straight line

Anæsthetic—Young children should be given a little chloroform Older children and adults may be given a local anæsthetic In urgent and desperate cases no anæsthetic is required it may be possible in these circumstances to pass a bronchoscope and ventilate the lungs through this whilst an incision is made down onto the now rigid trachea

1 **Exposing the trachea.**—First find and fix the cricoid cartilage by holding it between the finger and thumb of the left hand and never leave go until the trachea is exposed An incision is then made in the mid line of the neck extending from the upper border of the cricoid cartilage downwards for one and a half inches

The right hand must be unsupported If the operator rests his wrist upon the upper part of the child's chest as he is tempted to do he will find that the rapid movements of the thorax in laboured breathing render that part no proper place for support

The surgeon still fixing the trachea and soft parts with the left hand cuts deliberately in the middle line through the subcutaneous fat and the anterior layer of the cervical fascia The sterno hyoid and the sterno thyroid muscles are reached, and the interval between them is opened up All this is done by successive clean cuts

Keeping still to the middle line and still steadying the trachea he divides cleanly, and by cautious cuts the fascia covering it

At this stage veins will probably be encountered and may be displaced to one or other side by the handle of the scalpel The isthmus of the thyroid will be seen, and may be displaced downwards The operation is however greatly facilitated if the isthmus is deliberately divided between Spencer Wells forceps By rotating the forceps outwards, the trachea is fully exposed and the white cartilaginous rings can be seen as well as felt

2 **Opening the trachea**—A small sharp hook is now introduced into the cricoid cartilage and is held by the assistant who stands at the head of the table

The hook is kept precisely in the middle line and is used to fix and draw forwards the cricoid cartilage and to render the trachea tense The assistant must give a little play to the hook as the larynx moves with each inspiration

With the left forefinger the operator feels the upper rings of the trachea and with a slender scalpel held with the edge towards the patient's chin he carefully incises the trachea in

later, the serrated forceps alone are required in most cases to open the tracheal wound for the tube

A good tracheotomy tube should be of simple construction should be easy to introduce should be as large as the diameter of the trachea will admit should lie exactly in the long axis of the windpipe should have a movable shield so that it is disturbed as little as possible, and the inner cannula should be capable of being easily inserted and removed The tube should not be strongly curved or its end will irritate the tracheal wall Parker s angular tube fits best of all

Position of the patient.—The child is enveloped in a thin mackintosh sheet and is placed close to the right edge of the table The surgeon stands by the same side of the table The neck is supported on a firm sand bag of suitable size or some similar firm pillow An excellent substitute always at hand is a cylindrical bottle wrapped in a soft towel When the child is ready the head should be drawn well over the upper end of the table so that the vertex is turned nearly towards the ground

The sand bag will be placed close to the upper edge of the table and over it the child s head is extended in this extreme manner

This position renders the structures on the front of the neck tense steadies the trachea draws as much of that tube up into the neck as is possible and brings it somewhat nearer to the surface The superficial veins are moreover a little emptied of their blood by this attitude of over extension

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the median line some three rings below the cricoid and cuts up on to the hook (Fig 138) It is most important not to thrust the knife too deeply as thereby there is grave danger of wounding the posterior wall and even the œsophagus It is advisable to pare the margins of the tracheal incision with scissors thus converting a vertical slit into an oval foramen

The noisy rush of air entering and escaping through the wound the coughing of the child and the expulsion of mucus and membrane bring about a moment of confusion This is easily avoided, when time is not an urgent consideration, by the intratracheal injection of 5 minims of 1 per cent cocaine through a hypodermic needle After waiting a few minutes for the cocaine to act the trachea can be opened without producing the slightest cough The hook must not be removed It is allowed to remain as an easy guide to the median line of the trachea and the site of the opening therein The opening must be free

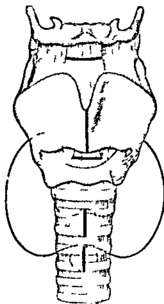


Fig 138 —Operations on the larynx and trachea

The high st incision is through the thyro hy id m mbrane Th ver tical incision is for the operation of laryngo fissu e The next hori zontal incision i f r laryngotomy The lower hori ont l incisi s are for high and low tr cheotomy The outli e of the thyroid gland is depicted

If the hook be not used the operator may run the risk of missing the slit in the trachea he has already made and may in his haste proceed to make another incision This is a fatal error

3 Introduction of the tube —The right margin of the opening in the trachea should be lightly seized with the toothed forceps which are held in the left hand and while the opening is thus for a moment demonstrated and fixed the tube and pilot are slipped in If the

forceps be employed as directed the tube can be introduced with certainty and ease The depth of the wound the quantity of blood and mucus which may fill it and the movements of the trachea, may readily cause the site of the opening to be lost especially if the trachea has not been well exposed and the fascia freely divided

It will usually be found more convenient to restore the child's head to the erect position before the tube is introduced When the tube is in place—and not before—the sharp hook is removed

Rapid and efficient sponging with small pieces of fine Turkey sponge is of great service throughout the operation

The tube is secured in place by tape and the wound below the tube is brought together by a suture or two of silkworm gut A piece of lint properly shaped and moistened with carbolic oil is placed under the shield of the tube and is made to cover and protect the wound

Comment.—*Qua* operation tracheotomy must be regarded as an easy and simple procedure Those who have performed it only upon the dead subject must be at a loss to understand the terrible possibilities with which the introduction of a tracheotomy tube appears to be surrounded In the adult it is true the operation is but rarely in any way difficult or complicated in an infant with a short stout neck on the other hand it may be attended with not inconsiderable difficulties Any deviation from the midline may imperil the cervical pleura whilst inferiorly the turgid innominate vein may project above the manubrium and be liable to damage

For the accidents which sometimes occur during tracheotomy the hurry and excitement of the operation and the fear that the child is ceasing to breathe are in the main answerable and not the anatomical conditions of the operation itself

It must be expected that in almost every case there will be free venous bleeding While it is well that the hæmorrhage should be checked before the tube is introduced lest blood find its way into the lung yet too long a time should not be

devoted to attempting to secure the vessels As soon as the tube is introduced, air enters the lung more freely the right side of the heart is relieved, and venous bleeding which before was very copious ceases almost immediately

The cervical fascia must be well and cleanly divided The tube has many a time been introduced between the trachea and the imperfectly divided fascia the operator being under the impression that it has been inserted into the windpipe No air however escapes

In cases where an extensive membrane exists it may escape division when the trachea is opened and the tube may then be inserted between the membrane and the tracheal wall In this case also no air escapes from the instrument

In most cases of tracheotomy performed by a novice or carried out with undue haste it will be observed that the time of the operation is taken up more by introducing the tube than by finding and incising the trachea

If the hook and the toothed forceps be used as described all bungling over the insertion of the tube may be avoided

The following rules should be observed —

1 Let the chin be kept rigidly in a line with the sternal notch
2 Cut only in the middle line
3 Avoid anxious assistants with retractors
4 See the white rings of the trachea and feel them bare before incising them
5 Take care not to cut too deeply *and only in the* mid line of the trachea Avoid nervous hurry, and do not be alarmed at some venous bleeding or blueness of the patient Once the tube is properly inserted both will rapidly subside

4 LARYNGOTOMY

Laryngotomy or the artificial opening of the larynx through the crico thyroid membrane is occasionally performed as a substitute for tracheotomy The operation has the advantage

of being rapidly and easily carried out It is quite in applicable to children under 13 years of age owing to the narrowness of the crico thyroid space The great draw backs of the operation are the proximity of the vocal cords and the difficulty of adjusting a suitable tube Laryngotomy is totally unsuited to cases in which a tube has to be worn for any length of time owing to the danger of laryngeal stenosis

Laryngo-fissure —By laryngo fissure is understood the division of the thyroid cartilage in the median line (Fig 138) so as to gain access to the interior of the larynx It is carried out in order to remove certain laryngeal growths and certain large or impacted foreign bodies especially such as have found their way into the ventricles

The operation involves a great danger of permanent interference with vocalization and in the treatment of morbid growths it is only employed when the intralaryngeal method of removal cannot be effectually carried out

Operation —The head is extended over a hard cushion or sand bag and is firmly held with the chin in a line with the sternal notch and the shoulders are raised Chloroform is the anæsthetic administered A preliminary median tracheotomy is carried out The position of the opening for the tube will depend upon the nature of the case the length of time the tube will probably have to be worn and upon other circumstances If the operation threatens to be exten sive as in dealing with large growths a tracheotomy will be found to be the more convenient but in such an operation as is carried out for the removal of a foreign body a laryngotomy may be selected

If much hæmorrhage is anticipated as will be the case in dealing with extensive papillomata the trachea must be plugged This may be effected by a tampon such as Trendelenburg s for air inflation or by gently plugging the trachea on either side of the tube with a piece of fine sponge properly shaped and attached to a long silk thread

The incision is prolonged upwards in the median line and the skin and subcutaneous tissues are divided down to the cartilage The incision will extend over the cricoid and

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may be needed to effect a division Bone forceps should never be employed

By means of two small sharp hooks the two alæ are now drawn aside and the interior of the larynx is exposed In old subjects it may be necessary to make transverse incisions in the crico thyroid and thyro hyoid membranes close to their respective cartilages before the fullest view desired can be obtained.

The foreign body may now be extracted or the growth removed.

In dealing with papillomatous masses the bulk of the growth may be crushed off with broad forceps and the remainder removed with scissors aided by Volkmann's spoon The surface left by the removal of the tumour may then be touched with a saturated solution of chromic acid or with the electric cautery

Finally the two portions of the thyroid cartilage are united by two or three fine sutures and the wound in the skin is closed

thyroid cartilages the crico thyroid space and some part of the thyro hyoid space

The thyroid cartilage is divided accurately and carefully in the median line the thyro hyoid and crico thyroid mem branes being also cut if necessary

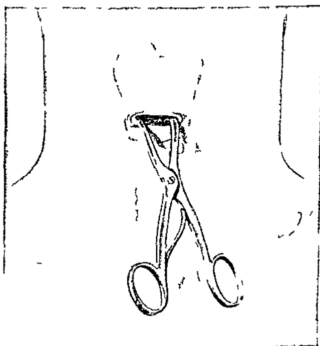


Fig 139 —Laryngotomy dilators tearing the crico thyroid membrane

The division of the cartilage should be effected from above downwards and from without inwards In young subjects and in females who have not passed middle life the section may be accomplished by a small but stout knife In aged subjects in whom the cartilage will be calcified a fine saw

terminate in the internal jugular vein The *middle thyroid vein* takes a similar course opposite the middle of the gland and ends also in the internal jugular vein The *inferior thyroid veins* frequently form a plexus lying in front of the trachea and terminate in the left innominate vein

Capsules—The thyroid has two capsules a true capsule consisting of the connective tissue of the gland and a false capsule derived from the pre tracheal fascia The numerous blood vessels must of necessity pierce both capsules and then ramify to form a plexus immediately within the inner capsule

The close relationship of the external laryngeal nerve with the superior thyroid artery and the recurrent laryngeal nerve with the inferior thyroid artery should be particularly noted as either of these nerves may be injured in the process of ligaturing the arteries unless care is taken to apply the ligature at the point where the artery enters the gland Injury to the recurrent laryngeal nerves results in permanent hoarseness, while injury to the external laryngeal nerve produces a temporary hoarseness which disappears in a few months when the opposite crico thyroid muscle takes upon itself the function of its paralysed equivalent

The parathyroid glands—There are normally four parathyroids each being about the size of a split pea and situated on the posterior surface of each lateral lobe in close association with the true capsule The inferior pair are intimately related to the inferior thyroid arteries and the superior pair are freely supplied by blood from the superior thyroid arteries Accessory parathyroid glands are frequently present The function of the parathyroids is related to the calcium metabolism of the body, and after parathyroidectomy the blood and tissues become deficient in calcium which is excreted in large quantities in the urine with the result that tetany supervenes Hyperparathyroidism due in many cases to a parathyroid hyperplasia is associated with generalized osteitis fibrosa in which condition excessive calcium is mobilized from the bones and excreted in the urine although much of it may be deposited as calcareous plaques in various parts of the body

CHAPTER II

OPERATIONS ON THE THYROID GLAND

Surgical Anatomy

The thyroid gland consists of two lateral lobes extending from the upper border of the thyroid cartilage down to the sixth ring of the trachea and connected together across the mid line by the isthmus which lies in front of the second third and fourth rings of the trachea A pyramidal lobe frequently extends upwards from the left side of the upper border of the isthmus and is connected to the hyoid bone by a fibrous band or muscle slip

The *anterior surface* is covered by the infra hyoid muscles and overlapped by the sterno mastoid muscles The *internal surface* is in contact with the trachea the œsophagus (particularly on the left side) the recurrent laryngeal and external laryngeal nerves and the inferior constrictor and crico thyroid muscles The *posterior surface* overlaps and is grooved by the common carotid artery

Blood supply—The superior thyroid artery a branch of the external carotid enters the upper pole on its superficial aspect and divides into three branches

The inferior thyroid artery a branch of the thyroid axis from the first part of the subclavian enters the lower pole of the lateral lobe on its deep aspect The thyroidea ima artery an occasional vessel arising from the arch of the aorta or the innominate artery ascends to the isthmus

Veins—There are three groups of veins which do not accompany the arteries

The *superior thyroid vein* crosses the common carotid to

inch above the supra sternal notch and following the line of the skin markings in the neck is usually employed The

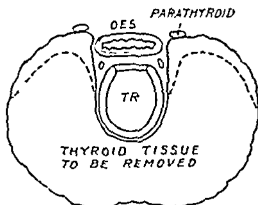


Fig 141 —Diagram illustrating the amount of thyroid tissue removed in the operation of subtotal thyrodectomy

flaps, consisting of skin superficial fascia and platysma are dissected up and the gland is exposed by incising the cervical fascia vertically in the mid line of the neck from the level of the thyroid cartilage down to the sternum The infra hyoid muscles are either retracted or divided between clamps and it is important that the line of their division should be much higher than that of the skin incision so that their nerve supply shall not be damaged and so that the scar which will result after their union shall not adhere to and pull upon the scar in the skin

The line of cleavage between the false and true capsules of the thyroid is found, and dissected either with a blunt instrument or the finger so that the gland is delivered into the wound Great care must be taken in ligaturing the superior thyroid arteries, and a double ligature accurately applied will secure peace of mind as well as hæmostasis The inferior thyroid arteries and the thyroid veins are divided between pressure forceps and ligatured Approximately seven eighths of the gland is removed leaving only a thin layer of the posterior part of each lateral lobe so as to safeguard the re

Anæsthetic—In no type of case is a basal anæsthetic more appropriately employed than in a case of hyper thyroidism It does a very great deal to alleviate the fearful apprehension which invariably exists in the patient's mind and which affects the result of the operation so adversely This is supplemented by intratracheal gas and oxygen and many surgeons use local infiltration of the skin and subcutaneous tissues with novocain Not only does this procedure diminish shock and minimize oozing but it also serves to separate the various fascial planes and thereby makes the dissection of the gland considerably easier

Operations

The operation of subtotal thyroidectomy will be described as most operations upon the thyroid gland employ a similar approach and are modifications of this technique

A collar incision (Fig 140) situated half an inch to one

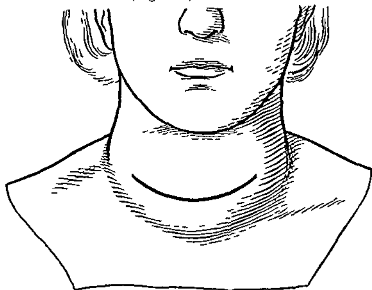


Fig 140—Parenchymatous goitre showing the collar incision

min. of Lugol's iodine the other, the complete reopening of the wound, both superficially and deeply, and its irrigation with hypertonic saline No attempt is made to resuture the wound at this stage, this may be performed when the patient's condition has sufficiently improved

It is not always advisable to perform subtotal thyroidectomy in one stage and when the pre-operative condition of the patient is precarious a many staged approach should be the method of choice It may only be safe on the first occasion to ligature one or possibly two of the thyroid arteries and after an interval to ligature the remaining two Subsequently one half of the gland may be removed or, under more favourable circumstances a subtotal thyroidectomy performed

Enucleation of an adenoma or cyst—This is a relatively simple procedure carried out through an incision similar to the above the only important point being to discover the appropriate interval between the adenoma or cyst and its false capsule which is formed by the surrounding compressed thyroid tissue Once this layer has been determined the process of enucleation is simple and relatively avascular Hæmostasis is secured and the dead space obliterated by interrupted catgut sutures

Surgical emergency—A state of emergency may arise in a patient with a goitre of long standing caused by sudden hæmorrhage into an adenoma or cyst and producing acute and even fatal dyspnœa This is particularly likely to occur if the adenoma is situated behind the sternum as any increase in the intraglandular tension results in compression of the trachea

Relief may be afforded immediately by *aspiration* through a wide bore needle but if this fails then an incision into the neck with division of the deep fascia will permit the gland to herniate through the deep fascia thus relieving pressure upon the trachea Division of the isthmus of the gland may be necessary in more obstinate cases Any of these methods will be followed by partial thyroidectomy when the condition of the patient has become favourable

current laryngeal nerves and provide an adequate amount of thyroid tissue for the future needs of the body (Fig 141)

If a large goitre has existed for a considerable time it may have produced such compression of the trachea as to lead to complete atrophy of three or four cartilaginous rings converting that portion of the trachea into a mere fibrous tube The removal of the gland permits this tube to collapse causing thereby a sudden and complete arrest of respiration This calamity can be anticipated and avoided by passing an intratracheal catheter through which the anæsthetic is administered

Before closing the wound it is advisable to irrigate it thoroughly with hypertonic saline to extract the excess of thyroxin lying in the wound the absorption of which is apt to produce acute hyperthyroidism in the course of a few hours

Divided muscles are accurately resutured the platysma if it has been divided transversely, is sutured separately and the skin margins are carefully approximated by the finest silkworm gut sutures a small drain always being inserted into the wound

Post-operative complications —(1) *Hæmorrhage* — This is almost invariably caused by slipping of a ligature on the superior thyroid artery an accident associated with great danger as the formation of a hæmatoma is likely to cause serious compression of the trachea unless very promptly relieved The artery is not easily secured a second time through the original incision and it may be necessary to expose it through a separate incision placed at a higher level over the origin of the vessel

(2) *Acute hyperthyroid reaction* —This very alarming and frequently fatal complication occurs far less often than formerly since the introduction of pre operative iodine treatment The onset occurs within a few hours of the operation and is typified by violent restlessness increased pulse rate a high temperature and profuse sweating Two measures may be of life saving importance the one is to inject intravenously 800–1 000 c c of glucose saline containing from 50–100

ones in cancer of the tongue may be defined with fair accuracy they are shown in Fig 142

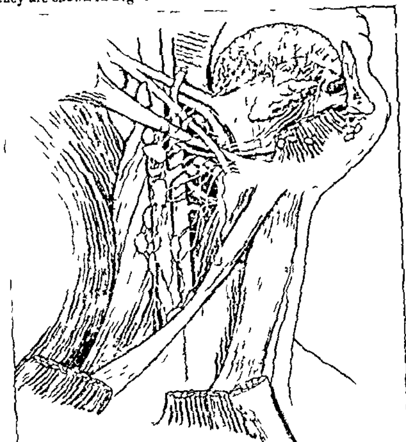


Fig 142 —*Glands of the neck in which cancerous deposits are likely to occur from epithelioma of the tongue*

There are four sets of efferent lymphatic vessels —

1 *Apical* with three possible destinations —

(*a*) to the lymphatics embedded in the submaxillary gland

(*b*) to the submental glands

CHAPTER III

EXCISION OF THE TONGUE, OPERATION ON THE LOWER LIP, REMOVAL OF TUBERCULOUS GLANDS

Excision of the Tongue

Excision of the whole or of part of the tongue is performed in some cases for squamous carcinoma Interstitial radium needles are widely used by some surgeons

This form of cancer usually commences on the lateral aspect of the tongue Whilst it is still confined to one side of the middle line there is no valid reason for removing the whole organ But at the operation it is frequently found to have extended more deeply towards the base and median line than had been suspected Supposing it has infiltrated the anterior portion of both sides the surgeon may often safely leave a stump formed of the posterior third or less If the whole tongue be excised the floor of the mouth will ultimately project upwards and take its place to a surprising extent but articulation is never as good as if a fair sized stump has been left and the constant flow of saliva may prove a nuisance to the patient The general rule may be laid down to cut wide of the cancer but leave any perfectly healthy part of the tongue Recurrence is common in the lymphatic glands rare in the stump of the tongue hence it is important to remove (either at the same time as the primary tumour or a few weeks later) all glands clinically involved with metastases Of course these glands must be mobile

The particular lymphatic glands which are the dangerous

Position—The patient has of course been shaved, and both sides of the neck have been prepared for operation The head and shoulders are well raised and sterile towels packed beneath the neck The chest is covered with a blanket, mackintosh and sterile towel

Operation—In most cases it is advisable to tie both the lingual arteries The surgeon commences on the side on which the cancerous growth is situated and on which the lymphatic glands will therefore require to be dissected out

During the first stage the gag is not introduced but it is often convenient to introduce a loop of silk ligature through the middle of the tongue so that in case the breathing should become embarrassed traction can be made on it

The patient's head is turned towards the opposite side and kept steadily in this position with the chin raised

1 *The incisions*—A curved incision is made from just below the angle of the jaw towards the symphysis it extends downwards towards the hyoid bone (Fig 143)

A second nearly vertical cut is made along the anterior edge of the sterno mastoid muscle for several inches nearly to the sternum

Both incisions are made through skin and platysma muscles and then more deeply through the fascia

The flaps are then dissected up so as to expose the sterno mastoid border for a considerable distance as well as the depressor muscles and the submaxillary gland The upper flap of skin platysma and superficial fascia is now reflected up to the jaw

At the lower posterior angle of the gland the facial vein is isolated as it emerges and cut across between two fine silk ligatures The fascial sheath of the submaxillary gland is cut through completely so that the latter can be raised by a broad retractor A communicating vein from the external jugular to the facial will probably require ligature near the angle of the jaw Deeply placed under the latter the facial artery is sought for and an aneurysm needle passed under it just before it enters the gland The artery is tied in two places leaving sufficient room for section between

(c) direct to the deep cervical glands on the carotid sheath

2 From the side of the tongue to the glands embedded in and around the submaxillary gland thence to the superior deep cervical glands

3 From the base of the tongue to the superior deep cervical glands

4 Median area to the submaxillary group of glands

EXCISION WITH PRELIMINARY LIGATURE OF THE LINGUAL ARTERIES ETC

Preparation of the patient —It is rarely possible to get the patient s mouth as aseptic as could be wished but all teeth should be removed and weak carbolic or Milton antiseptic mouth washes frequently employed during the days immediately preceding the operation The patient should be taught to use a feeding cup with a rubber spout

Instruments required —Mouth gag , curved needle in handle stout silk tongue forceps mouth retractor, tenaculum blunt pointed scissors straight and curved volsella Wells s pressure dissecting and fine toothed forceps sponges in holders ligatures etc scalpels retractors blunt hooks aneurysm needle needles and sutures

The instruments required for the first stage including ligature of the linguals and dissection of the glands should be in one dish whilst those required for the second stage—the actual excision of the tongue—should be kept in a separate dish

The best gag is Mason s or Hewitt s It must be strong and the blades capable of wide separation The catch fixing the gag when open must be secure A catch ' is better than a screw

The best cheek retractor is the broad rectangular retractor used in nephrectomy operations

The scissors used for cutting out the tongue should be large ones slightly curved on the flat They should end in square blunt points The cutting edge should extend up to the very tip

surrounding connective tissue so as to leave the great vessels largely denuded This involves a rather long and delicate dissection in which the knife is aided by the narrow blunt elevator (Cheyne s dissector) In the course of it the sterno mastoid muscle is well retracted by a stitch or otherwise and if necessary the muscle may be cut across Particular attention must be paid to the lower part of the parotid, under which lie one or two glands, there is no harm in ex cising a portion of the salivary gland itself (no fistula will result) Should an infected gland be firmly adherent to the internal jugular vein, it may be necessary to excise part of the latter between two ligatures, but with care this can almost always be avoided

3 *Ligature of the lingual artery*—This is rendered very easy by the removal of the submaxillary gland The digastric tendon is drawn down with a blunt hook and the small tri angle formed by the hypoglossal, the posterior edge of the mylo hyoid and the posterior belly of the digastric is de fined In this triangle the fibres of the hyo glossus are divided and separated the artery should be at once exposed and tied

4 *Closure of the wound with drainage*—Before closing the wound the whole is washed with warm water and any bleeding vessels that have escaped ligature hitherto are secured The tied ends of the facial artery and vein are inspected and if necessary a second ligature is applied The extensive wound is rapidly sewn up with silkworm gut and a drainage tube of some length but small calibre is inserted, coming out at the lower angle of the wound

A light gauze dressing is laid over the wound and the head turned over, the operator moving to the opposite side of the neck and the table of instruments being brought round

5 *Ligature of the opposite lingual artery*—If the epithelioma is entirely confined to one lateral margin and does not dip deeply this step may be omitted In most cases it will suffice to make the usual curved incision to turn up the sub maxillary gland and to secure the lingual in the triangle

the ligatures This being done the gland is freed still further by the use of the scissors and drawn forwards and outwards from its bed beneath the jaw The facial vessels as they mount over the horizontal ramus will require another ligature In front the gland is cleared off the mylo hyoid and digastric muscles and it only remains to put a ligature round Wharton s duct The salivary gland, with all lymphatic glands in the

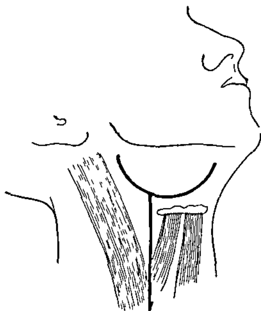


Fig 143 —Incisions for ligature of the right lingual artery with removal of lymphatic glands

The sterno mastoid muscle the hyoid bone and its depressor muscles are indicated

submaxillary space and a constant outlying gland lying in front of the masseter muscle is thus removed in one piece

2 *Dissection out of lymphatic glands*—Turning now to the glands along the jugular vein and over the bifurcation of the carotid (*see* Fig 142), the operator removes these with all

the scissors any bleeding vessel is caught in Wells s long forceps but generally the section is practically dry

As a precaution a loop of silkworm gut or silk suture may be inserted through the portion of tongue left, this enables it to be drawn forwards by the Sister in charge if breathing is embarrassed before the patient comes round, and also facilitates sponging

Before the patient is sent from the theatre the neck dressings are seen to, and it is important that there should be no great pressure exerted by the bandage

Until the patient comes round from the anæsthetic he should be kept lying somewhat on the side and a nurse should u e a mounted sponge from time to time in the mouth When he has come round, the head and shoulders should be well supported by pillows as venous oozing will be diminished by this means

The *after treatment* involves sedulous care in cleansing the mouth (1 in 100 carbolic solution is one of the best washes) and in feeding the patient with fluid food for several days The neck wounds require to be protected above from contamination by the saliva etc they heal remarkably well

The patient should be under supervision for at least a year after the operation so that if other glands enlarge on either side of the neck they may be dealt with

OTHER METHODS OF OPERATING FOR CANCER OF THE TONGUE

1 Intrabuccal excision with scissors, without preliminary ligature of the lingual arteries which are caught and tied as they are divided (Whitehead s operation)

2 The same procedure followed two or three weeks later by an elaborate dissection out of the lymphatic glands in one or both anterior triangles (Butlin s operation) Laryngotomy may form part of the first stage of this double operation

3 During the second operation the sterno mastoid is divided low down and turned upwards and the internal jugular vein is ligatured and removed with the glands (Crile)

4 Division of the lower jaw in the mid line, after drilling

already described Any lymphatic glands found about the carotid bifurcation can be dissected out at the same time The ligature itself from the commencement of the incision to its closure by suture will probably not take ten minutes A small drainage tube is inserted and another gauze dressing applied The neck dressings are both lightly secured in place with a gauze or muslin bandage

As these patients are usually worn out before they come to operation it is better to leave excision of the tongue until they have recovered from the present ordeal

6 *Excision of the tongue* —It will be convenient for the operator to stand on a stool by the operating table thus looking well down into the patient s mouth The assistant on the opposite side is armed with the sponge holders The anæsthetist adjusts and opens the gag to its full extent and the cheek on the side of the operator and the lower lip are well retracted When the gag is opened it often happens that the breathing becomes obstructed and the patient somewhat cyanosed, this condition should be relieved by traction on the tongue made with the ligature, and by holding the jaw forwards

From this moment no further anæsthetic is required, as a rule

The operator draws the patient s tongue out of the mouth by means of volsella forceps or of the silk ligature held in his left hand with the scissors in the other hand he divides the frænum of the tongue and the muscles beneath it thus enabling it to come well forward The rest of the excision will depend entirely on the position and extent of the epithelioma but *it must be free* well wide of the cancer all round and especially towards the floor of the mouth No attempt should be made to limit the excision in order to secure a suitable wound for suturing In very few cases of cancer of the tongue is it wise to try a wedge excision with subsequent suturing these cases are the uncommon ones limited to the tip The raw surface left after a free excision heals remarkably well The excision is carried out entirely by

side with the chin held steadily up The head and shoulder slope upwards on the raised end of the table

The operator begins a curved incision just below the point of the chin carries it down to the hyoid, and up to the angle of the jaw The flap of skin and platysma is raised as high as the lower border of this bone, and the whole submaxillary space cleared out as described at p 303 Note the close relation of the lingual nerve to the gland and to Wharton s

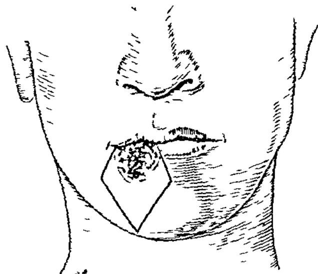


Fig 144 —Incisions for removal of small epithelioma of the lip

duct, care must be taken not to damage this or the hypo glossal nerve The branches of the lingual to the ganglion and gland are cut through

Note also the risk of overlooking veins beneath the angle of the jaw which enter the parotid region and communicate with the external jugular they may show but little during the operation but unless secured may cause serious recurrent hæmorrhage after it

After the triangle is cleared, if any obvious glands are

each half to one side of the symphysis in order subsequently to unite it by silver wire Cases in which this procedure is required must be very few, ample access to the tongue can be obtained without it The same remark applies to slitting the cheek open

Radium Treatment —Radium is now frequently used in cases of carcinoma of the tongue A drawing is made on squared paper of the primary tumour and with the aid of the physicist a plan is drawn of the position of the needles which gives a uniform field of irradiation Knowing the volume to be irradiated and the total dosage (6–8000 r in seven days) the number of milligrams of radium to be used can be read off a graph Note must be made that the eye and point of the needles contain no radium salt and are relatively inert The needles are placed in and around the tumour according to the plan by means of forceps (Fig 264) p 572 and tied in

Operation for Epithelioma of the Lower Lip

Formerly the surgeon limited this operation to a free excision of the local growth leaving the lymph glands to be dealt with later if they enlarged Although permanent cures resulted in a fair proportion of the cases the prognosis has been greatly improved by the adoption of more radical operations

The lymphatics of the lower lip drain into glands in the submental area (between the anterior bellies of the digastric muscles) and also in each submaxillary triangle thence they pass to the upper deep cervical glands If the epithelioma is placed well to one side of the mid line it will suffice to clear out the submaxillary triangle on that side if it passes beyond it both these triangles and the submental space must be dealt with We will describe the more extensive operation noting that it resembles in many respects the operation already advised for cancer of the tongue though it is both less severe and more certain in its results

The operation —The patient s chin and neck have been shaved and the skin rendered aseptic The anæsthetic with preliminary injection of morphia and atropine is given in the usual way, the patient s head is turned slightly to one

other part of the body so sure can one be of removing all lymph glands likely to be involved

Removal of Tuberculous Glands

This operation varies greatly in range and difficulty of performance and it is impossible to describe any formal method but the following points may be noted

1 The skin incisions should within reasonable limits be kept as short as possible and placed in the line of a natural fold or crease In the anterior triangle this can be effected by a horizontal incision and in a curve about the level of the hyoid In the posterior triangle the incision must be placed so as to give the most direct access to the group of glands

Very long vertical wounds in the neck (e g from mastoid process to clavicle), especially if the operator divides or resects the sterno mastoid muscle result in a deplorable disfigurement which could have been avoided and which the patient will always resent

The aim of the surgeon must be to leave scars as supple and inconspicuous as possible Any part of the skin infiltrated with tubercle or puckered with sinuses must be excised The wound is sewn up with the finest silkworm gut (ophthalmic), there is nothing better and the necessary drainage is provided by a small calibre tube (the spiral rubber one or a few strands of ligature answer best)

2 The larger cutaneous nerves if met with should not be divided, they can almost always be retracted The exact position of the spinal accessory nerve in either triangle should be borne carefully in mind and the greatest care taken not to divide it It often happens that during the dissection of a gland a warning twitch of the sterno mastoid or trapezius shows that the nerve has been touched by the knife or elevator

Note that the nerve usually crosses the internal jugular vein obliquely on its superficial surface enters the sterno mastoid muscle an inch below the mastoid tip emerges from the posterior border of the muscle one third the way down and runs obliquely across the posterior triangle It is easy to

found about the carotid bifurcation they are dissected out, but it is unnecessary to prolong the incision so far down as is shown in Fig 143 A gauze sponge is placed in the cavity and the operator continuing from the opposite side of the neck repeats the incision and dissection Towards the mid line the digastric muscle on either side is bared and the submental glands and areolar tissue are removed down to the mylo hyoid muscle and from the symphysis to the hyoid

It is practicable to remove in one continuous piece all the contents of both submaxillary triangles and the sub mental space It will be understood that both facial arteries have been ligatured and thus the next step a free removal of the primary growth is rendered almost bloodless

The incision should allow a full half inch of normal tissue all round the epithelioma it is made in the shape of a capital U and should approximate more to a rectangle than to the letter V (as used to be advised) (Fig 144)

All three wounds are now sewn up with silkworm gut care being taken to include the whole thickness of the lip and to get an even upper border and in the lower wound to provide drainage on both sides

Now and then so much of the lip may have to be removed that a plastic operation moving flaps up from the chin to form a fresh lower lip is necessary

Note that there is no part of the body that settles down" after a free excision with or without plastic measures better than this region The appearance may be very ugly at first but is most satisfactory in the end

Comment —Some surgeons employ, instead of the double curved incision a simple transverse (collar) wound parallel to and just below the jaw from one angle to the other (Beckman Mayo)

If the cancer is strictly unilateral on the lip the operation is limited to that side of the neck and the time taken is of course halved But the complete operation on both sides to one experienced and well up in the anatomy, should not take much more than an hour The chances of permanent cure are better after this operation than for cancer in any

so broken down that the use of the sharp scoop must suffice, at any rate in part Such a cold abscess may be gently curetted through a very small incision which is sutured Provided the erasion is done thoroughly, the wound will heal well

In dealing with a tuberculous abscess superficial to the deep fascia, care must be taken to remove the gland beneath the fascia which is the real cause of the abscess

Operations on the Submandibular Salivary Gland and Duct

Removal of a calculus from the duct —The stone will be felt in the floor of the mouth or seen protruding from the orifice of Wharton s duct Its actual size shape and position should be previously confirmed by X rays

Where the stone is near the duct orifice it is best removed by slitting up the duct with sharp pointed scissors one blade of which is placed inside the duct The stone is withdrawn with suitable forceps (Desjardin s are useful) and a gush of pus and saliva follows

Further back in the mouth there may be considerable difficulty in fixing the stone whilst making an incision over it A good plan is to insert a stay suture in the mucous membrane on each side of the stone

The operation may be performed under general or local anæsthesia In the former case it is important to pack off the pharynx and to use an endotracheal tube In the latter only a small quantity of anæsthetic solution should be injected since the area is easily obscured by too large a bleb There is no need to suture the incision in the mouth It is of no consequence if saliva issues from a widened or ectopic orifice

Excision of the submandibular Salivary Gland — This is indicated for stones in the gland itself for chronic infection mixed salivary adenomas and is incidental to block dissection of glands of neck for carcinoma

A straight incision 3 inches long is made in the sub maxillary triangle 1 inch below the horizontal ramus of the

mistake a branch of the cervical plexus for it in the posterior triangle The nerve may be injured when removing the jugulo digastric gland lying beneath the angle of the jaw The danger area ' often manifests itself by bleeding from the sternomastoid branches of the occipital and posterior auricular arteries

In dissecting out glands from over the jugular and carotid the descendens hypoglossi should be looked for and preserved Of course if any nerves are unavoidably divided their ends should be sutured together with the finest silk

3 Hæmorrhage (it will mainly be venous and any small arteries are readily secured) must be guarded against by keeping very close to the gland capsule now and then by scraping the softened gland tissue away from the capsule firmly adhering to important vessels Whilst traction is being made on the glands especially when they are almost freed the tension should be relaxed from time to time in order to identify the vein wall

It is rarely necessary to ligate or excise the internal jugular vein itself (in less than 2 per cent of these operations—Sutcliffe) Division of the sterno mastoid muscle, it may be noted is hardly ever necessary but some operators do not hesitate to divide it if a mass of glands extends beneath it from one triangle to the other

4 In clearing away the glands it is best to begin from the side on which danger lies e g the jugular vein or carotid artery to cut with caution and to use the blunt dissector or elevator more freely Keep close to the capsule make no cut in the dark and be cautious of dividing tissues which are only seen when put fully on the stretch Denude the glands first from one part of their circumference then from another When a small pedicle only remains take hold of this with Wells s forceps before cutting it through

5 Dissection of glands low down in the posterior triangle on the left side must be carried out with extreme caution on account of the thoracic duct

6 While clean excision of the tuberculous glands is the most satisfactory treatment it often happens that they are

the mylohyoid muscle is displayed This is the key landmark of the operation

The superficial part of the gland lies on this muscle with the deep part and duct behind lying on the hyoglossus Below the gland is the digastric muscle The superficial part of the gland is dissected free and the hypoglossal nerve and ranine veins are demonstrated deep to the inferior border lying on the hyoglossus Posteriorly the gland is grooved by the facial artery which has often to be divided in two places Posteriorly too but superficial to the gland is the anterior facial vein which has to be ligatured The parotid gland may be seen behind separated from the submandibular by the stylomandibular ligament The deep part of the gland and the duct are then dissected out with due regard to the lingual nerve which accompany them The duct is ligated and the gland removed The wound is closed with drainage

Excision of this gland may be a pretty anatomical exercise When however, it has been inflamed it is often swollen and firmly adherent to surrounding structures making removal a tedious process The secret of the operation is definition of the mylohyoid edge the hyoglossus and digastric muscles The hyoglossal and lingual should always be identified before removing the gland

mandible. Care must be taken not to extend the incision into the space between the angle of the jaw and mastoid process for fear of damaging the facial nerve. The mandibular

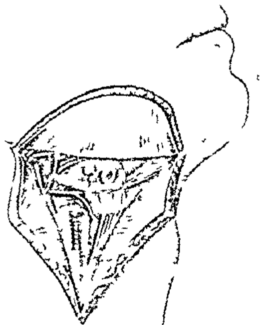


Fig. 147. Diagram of the anatomy of the submandibular triangle showing relationships of the submandibular gland

as Senokot, and of course enemata must be used prior to any operation on the bowel itself

The abdominal skin is prepared by shaving and washing with soap and water The umbilicus particularly should be cleansed especially if deep An hour before the operation omnopon, gr $\frac{1}{3}$–$\frac{1}{2}$ and scopolamine gr [illegible], is given hypodermically

If the patient has been vomiting or if the stomach or spleen are being operated upon a small stomach tube should be passed and left in situ

Make sure that the bladder has been emptied shortly before the patient comes to the theatre if there is any doubt about this pass a catheter

The position of the patient during what will be perhaps a long operation is most important In the vast majority of instances the patient will be supine and only occasionally will the Trendelenburg position be required

A pneumatic cushion is used in renal and gall bladder operations instead of a pillow

The 'field of operation' should be isolated by sterile towels over thin mackintosh, the four towels being secured together by clips or forceps, which are then tucked under the towels

The parietal incision—The exact site and length of this will of course depend on the condition to be treated and will be considered in later chapters Note that median incisions above the umbilicus are less likely to be followed by yielding of the scar and ventral hernia than those made below this level But whether made above, below or (as will often be required) both above and below the umbilicus, the risk of ventral hernia can be prevented by one of the following modifications of the strictly median incision

(1) *Near midline*—Place it half an inch to an inch to one side of the median line (it is advisable to ascertain this for certain) and parallel to it open the rectus sheath in this line divide the rectus muscle along and between its fibres then the posterior layer of its sheath and finally the transversalis fascia and peritoneum (Fig 146)

PART VIII—OPERATIONS ON THE ABDOMEN

CHAPTER I

ABDOMINAL SECTION

The term abdominal section is applied to the opening of the abdominal cavity either for purposes of exploration or with the object of operating upon the abdominal or pelvic viscera

Special instruments required—For abdominal section for special conditions e g gall stones or duodenal ulcer special instruments will be required for each operation The following will be necessary for almost every abdominal operation Pressure forceps (ten or more pairs) large pressure forceps (two or three pairs) medium sized pressure forceps strong curved needles for the parietal sutures needle holders small needles (curved and straight) two large blunt hooks scissors (straight and curved on the flat) catgut and silk in various sizes silkworm gut gauze swabs and square pads to each of the latter a long tape is sewn a precaution which entirely prevents the risk of a pad being overlooked in the abdomen An electric head lamp may be very useful in certain ca es

Preparation of the patient—It is best not to keep the patient in bed prior to operation Ambulation encourages chest movement and helps to promote venous circulation with lessened risk of post operative thrombosis If a patient has to be confined to bed breathing exercises and limb move ments should be carried out for a few days Proper action of the large bowel may be obtained with mild aperients such

(3) *Battle's pararectal incision* —Incisions along the outer border of the rectus inside the linea semilunaris are used for certain gall bladder operations above the umbilicus and for appendix operations below this level The sheath of the rectus is opened, the outer edge of the muscle displaced towards the middle line, and the posterior layer of the sheath etc, incised Low down below the level of the fold of Douglas there will be only one layer of aponeurosis to divide in front of the rectus Entering the muscle at its outer edge are the ninth to the twelfth intercostal nerves and every effort must be made to avoid their division which would result in a paralysis of the part of the rectus muscle supplied by tho e segmented nerves The position of the deep epigastric vessels should be borne in mind if the incision is placed low down In the upper part of the linea semilunaris it will be found difficult to sew up the posterior sheath layer owing to tension

For most purposes the paramedian incision will be found the best In case of need a transverse incision across the rectus muscle and its coverings may be added at any required level the sub equent suturing demands care and is somewhat awkward to effect, but no material damage is done to the muscle

In planning his incision through the abdominal wall, the operator aims to give an access to the interior which can if necessary be enlarged by extending or modifying the wound and at the same time to prevent the risk of ventral hernia

In closing the wound it is very important to leave a smooth peritoneal surface in order to prevent the occurrence of adhe ions The desired result is usually best obtained by a separate line of suture with catgut through the peritoneum and adjacent layers

We will suppose the incision made down to the peritoneum identified best by noting the tissues cut through perhaps also by seeing intestine or other viscus through it Before any attempt is made to open the abdominal cavity all bleed ing should have been checked Any pressure forceps that

(2) *Paramedian* —The rectus sheath being opened in the above line the inner border of the muscle is made free by blunt dissection and retracted outwards the posterior layer of the sheath etc being then divided in the original line When the wound is to be closed, this implies three distinct layers of

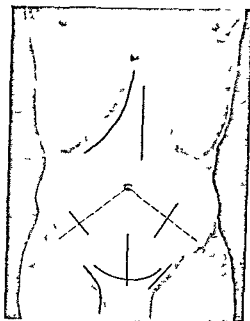


Fig 146 —Abdominal incisions

The two upper incisions may be used for removal of gall bladder the muscle splitting incisions for appendicectomy (on the right) and colostomy (on the left)

suture and time may press The first method allows a single row of silkworm gut or steel sutures to traverse all the layers—a distinct advantage at times As regards firmness of scar there is little difference between the results of the two

The so called gridiron method is described in the chapter on Appendicectomy (p 356)

the insertion of the sutures Before they are dispensed with the little margin of peritoneum which they have hold of should be cut away with the forceps since this tissue is likely to be damaged by long compression When the forceps are in position, two fingers can be introduced for purposes of exploration

If the incision has to be enlarged this is done with scissors the two fingers being used as a grooved director If the wound be extended downward the position of the bladder must be defined before the knife is used

If the hand has to be introduced, the incision must of necessity be increased There is often a disposition not to make the wound large enough More harm may be done by rough efforts to drag a solid growth through a small incision than by a liberal extension of the incision in the abdominal wall

In certain cases as soon as the wound has been completed, a large gauze swab may be at once introduced into the pelvis It is retained there during the operation and by absorbing any blood that finds its way into Douglas s pouch saves sponging at a later stage This gauze swab has a long tape attached one end of which remains projecting from the wound, and will prevent its being forgotten The intestines must be prevented from protruding, either by the introduction of a flat artificial sponge or by the fingers of an assistant One of those present should be entrusted with the responsibility of taking count of all swabs introduced into the abdomen

The gauze swabs which are used for temporary sojourn in the abdomen have of course been numbered and at the end of the operation their return is duly ascertained No smaller swab or sponge—without an attached tape—should be allowed to be loose in the abdomen even for a moment it must be held in the hands of the operator or his assistant while being used and then thrown away It is a good rule never to u e swabs once the peritoneum has been opened a long roll of gauze serves the purpose just as well and is not so easily mislaid

are attached need not be removed at the present stage The peritoneum should be picked up as a minute fold with a pair of fine pointed forceps Normal peritoneum can be so picked up Thickened and adherent peritoneum cannot be thus dealt with nor can the wall of the bowel be quite so readily and minutely picked up should a piece of gut be exposed and its surface be mistaken for the lining membrane The forceps that grasps the little fold of peritoneum should be moved to and fro and lifted up and down to ascertain whether the membrane is free or not The membrane is finally divided by cutting upon or close to the point of the forceps, while this is being drawn away or lifted up No hook or other unusual instrument is required to pick up the peritoneum but a pair of toothed forceps is essential

Where adhesions exist there is difficulty in ascertaining when the abdominal cavity has been really reached and there is nothing to guide the operator but his surgical and anatomical intelligence Any doubtful layer of tissue should be picked up and gently rolled between the finger and thumb Its character can in this way be at once estimated and the existence of deeper attachments demonstrated The operator who has the fear of adhesions before his eyes and who has not noted the layers of tissues as they have been cut may readily separate and strip off the undivided peritoneum with his fingers under the impression that he is dealing with adhesions within the abdominal cavity This is especially apt to occur when a large smooth tumour is pressed against the parietes

The peritoneum should be divided by a clean even cut with scissors using the left index finger as a guide Better still the index and mid finger are used to lift up the peritoneum from the intestine etc while the scissors divide it between them

As soon as the abdomen is opened the divided peritoneum on either side of the centre of the wound is seized with pressure forceps These forceps remain in place until the operation is completed They act as retractors they keep the peritoneum in position and they render the introduction of the finger or of a sponge very easy They also serve as a guide to

false membranes are probably nourished from the viscus to which they are attached and we have seen no harm to follow from leaving quite considerable masses of such tissue attached to intestine In cases where a portion of cyst-wall is firmly attached to the bowel it is very undesirable to make persistent attempts to separate the two It is far better to cut away the cyst leaving the adherent portion still attached to the bowel Such attached portion may be reduced to the smallest dimensions by dissecting off as many laminæ as possible and be allowed to remain as a permanent appendage to the gut

It should be borne in mind that, in endeavouring to free the intestine of firm adhesions it is very much easier to tear the bowel than to tear the false membrane

Moreover such attempted separations even when they do not tear the gut are apt to strip off a great deal of its peritoneal coat The muscular coat beneath is probably atrophied from disuse the result of the adhesion and a perforation of such damaged intestine is quite possible Extensively adherent intestine will be found to have very attenuated walls and to be most readily torn

Adherent omentum can be dealt with in considerable sections The adhesions may be peeled off with the finger Portions of the thickness of the forefinger may be included in one ligature It is more satisfactory however in dealing with omentum, to ligature the individual vessels with fine silk whenever practicable The method adopted must depend upon the vascularity of the tissue In some cases where much traction has been exercised upon the omentum its cut surface will scarcely bleed at all On the other hand when an ovarian cyst with a twisted pedicle is obtaining its chief or sole blood supply from omental adhesions the vascularity of the tissue is often considerable

Adhesions may in some cases be so dense so close and so extensive that they have to be divided with scissors or the scalpel by extensive incisions It must be borne in mind however that such adhesions have sometimes but a slight vascularity and that they can often be divided without remark

The omentum often gives much trouble especially the fine thin omentum of young children by clinging to the fingers and to sponges and by becoming entangled with instruments It may be necessary to keep it out of the way by means of a long narrow sponge attached to slender forceps

Treatment of adhesions—Adhesions must be dealt with according to common surgical principles The lighter more recent and more slender can be broken down by the finger or by a sponge

The firmer must be clamped divided and tied with catgut Extensive strands of adhesions should be clamped in section cut and the bleeding points picked up individually with artery forceps and tied in the usual way

Oozing from a level surface can very easily be checked by continued pressure with a sponge If the oozing be persistent and if no individual vessels can be isolated and tied the bleeding surface when small may often be sequestrated' or sewn over A Lembert s suture is made to traverse the peritoneum on either side of the bleeding area and when the suture is drawn tight the bleeding surface is covered over When the area is large a fine needle carrying catgut is made to pass beneath the bleeding surface and when this buried suture is drawn tight the surface is constricted and turned in This may be called sewing in as compared with sewing over when peritoneum is employed Great care should be taken in dealing with deep pelvic adhesions They can be exposed by the use of spatulæ and in demonstrating their character and attachments reflected light from a mirror or the electric lamp is very useful The Trendelenburg position may be advisable

Adhesions to the bowel and to the bladder must be gently dealt with When slender they can be readily stripped off by means of a sponge When dense and extensive it is better to clamp the adhesion to cut it through at some little distance from the viscus and to ligature it *in situ* In separating adhesions from bowel it is easy to tear away the serous coat and to expose or even tear the muscular coat Such

It is well that any effusion such as blood or cyst-fluid, should be removed by means of an aspirator or 'sucker", the peritoneal cavity should never be washed out with antiseptics or even sterile water, this spreads infection to uninfected areas

On completing every intra abdominal operation, great care should be taken to ensure that no sponge or instrument has been left in the depth of the cavity The taped swabs are removed and counted as already noted, no others should

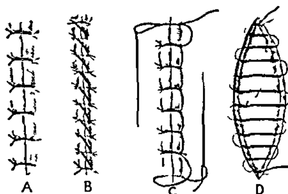


Fig 147 —Various forms of skin suture

A —Interrupted Suture B —Continuous Suture
C —Blanket Stitch D —Subcuticular Stitch

have been given the chance of remaining there The innumerable accidents which have occurred in the past from neglect of these simple precautions fully justify the emphasis laid on them

Closure of the abdominal wound—In sewing up the incision made through the abdominal wall the surgeon should aim at leaving the parts as far as possible in their normal condition i e the peritoneal surface should be smooth and the scar in the muscular and aponeurotic layers firm and unyielding Thus the possible dangers of adhesions of intestine omentum etc and of ventral hernia will be avoided Further if any buried sutures are employed

able bleeding Indeed we have observed that the hæmorrhage from a surface exposed by such division is usually not so considerable as that from an area exposed by tearing down soft recent adhesions with the finger Still these dense attachments must always be regarded with the greatest respect

In many instances when an organ, such as a cyst or a diseased vermiform appendix is so very adherent as to be described as buried or lost in adhesions it is well to ignore at first the actual adhesions and to divide the peritoneum at some little distance from the adherent organ so as to open the subserous tissue The finger is introduced into this lax tissue and the separation of the organ is carried out subperitoneally the adhesions being divided upon the finger (introduced beneath them) as soon as they are well isolated

Whenever practicable it is desirable that a very adherent structure should be first of all approached by the subperitoneal route When no inflammatory adhesions exist but when the tumour or cyst has in enlarging made its way beneath the peritoneum so as to become more or less entirely hidden then the separation of the mass should always be effected by dividing the peritoneum around it and by enucleating it through the medium of the subperitoneal tissue In such a proceeding care must be taken to note the position of the normal blood vessels of the part concerned These are secured as they are met with

Toilet of the peritoneum in septic cases— In an abdominal operation in which no septic material is encountered—and the majority of abdominal sections are of this type—the peritoneum should be gently handled or sponged care should be taken to leave no raw uncovered surfaces and especially to suture it smoothly in the deepest part of the wound Apart from this the peritoneal cavity by itself needs little attention The serous membrane is very well able to look after itself and the more one sees of abdominal operations the more one is impressed with the marvellous powers of the peritoneum in this direction

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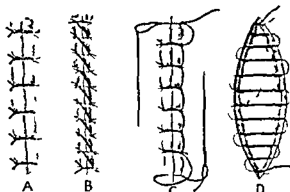


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Closure of the abdominal wound—In sewing up the incision made through the abdominal wall the surgeon should aim at leaving the parts as far as possible in their normal condition i e the peritoneal surface should be smooth and the scar in the muscular and aponeurotic layers *firm and unyielding* Thus the possible dangers of adhesions of intestine omentum etc and of ventral hernia will be avoided Further if any buried sutures are employed

they must be absolutely aseptic otherwise they are apt to cause troublesome sinuses which will only heal on the expulsion of the sutures

In some operations where time presses or tension is marked (e g after operation for intestinal obstruction) and especially if a median or paramedian incision has been used a good plan is to pass silkworm gut stitches through skin, aponeuroses, muscle and peritoneum By far the easiest way to introduce them is to thread each end on a curved needle and pass them from the peritoneal surface through the muscle and skin These sutures are securely knotted and should be left in for a full fortnight A more perfect peritoneal surface can however be obtained by first suturing the two cut edges of peritoneum and transversalis fascia sometimes of deep aponeurosis also A continuous suture line of catgut introduced on a curved needle is the most convenient The rectus sheath is closed with interrupted or continuous catgut sutures using a stronger catgut than was employed for the peritoneum and the skin is approximated with interrupted silkworm gut nylon or silk sutures which are carefully inserted so as to evert the skin edges (Fig 147) If it is thought that the patient s powers of healing are diminished by malnutrition or carcinomatosis or there is much distension suture of the abdominal layers with some form of non absorbable material such as steel wire silk nylon or thread is preferable to catgut

If the abdominal incision be extensive, a gauze swab or piece of sterile rubber sheeting to which a tape is attached is placed immediately beneath the peritoneum to be sewn up It is retained during the introduction of the sutures It serves to protect the intestines and to absorb such blood as oozes from the suture points before the sutures are tied

CHAPTER II

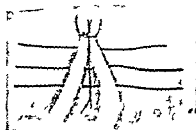
METHODS OF UNITING INTESTINE, ETC

WHETHER the operator has to close a wound in the stomach or intestine or to unite stomach to jejunum (gastro jejunostomy) or the two ends of a resected intestine or to perform lateral anastomosis with or without resection, the procedure is very similar in all cases so far as the best method of obtaining union is concerned All the varieties of mechanical aid such as Murphy's button however ingenious, have had their day and have fallen into disuse The operator trusts to careful suturing, and to that alone Four light intestinal clamps a pair for crushing the intestine fine curved and straight needles, a good needle holder and a pair of finely pointed forceps are required besides the usual instruments for an abdominal section Fine catgut on eyeless round bodied intestinal needles is the suture material most commonly employed

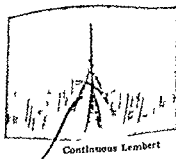
The suture should invariably consist of two parts the first row passing through all the coats of the intestine the second or supplementary row including only the peritoneum the muscular and elastic coats but not the mucous membrane This second row is therefore Lembert's suture which approximates the serous coats and forms an efficient watertight seal in a few hours Whether the sutures are continuous or interrupted matters but little, except that a continuous one takes much less time and is easier to do than a series of interrupted ones Certainly for the inner row—that traversing all the coats—the continuous one is to be preferred because it is hæmostatic The continuous and the interrupted Lembert's sutures are illustrated in Fig 118

The rule may again be emphasized when performing anastomosis or closing an intestinal wound do not rely on a single row of sutures but always reinforce the first by a second one

I **The continuous suture method**—This may be illustrated by the closure of a wound in the length of the intestine (Fig 149) The suture commences a few millimetres from one end of the wound the first traverse is tied in a



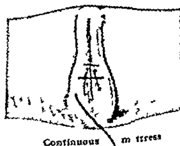
Interrupted Lembert



Continuous Lembert



Interrupted mattress



Continuous mattress

Fig 148 —Methods of suturing the peritoneum

double reef knot leaving the free end of suture (indicated by O in Fig 149) to be held by the assistant so as to straighten the wound After two or three Lembert traverses—i e dipping through peritoneum and muscular coats to the submucous—the end of the wound is reached when the thread is made *to take up all the coats* and so through the length

of the wound Every third traverse a single knot is tied, this gives extra security Finally when the uninjured portion of the intestine is reached at the other end of the wound a few Lembert sutures are made as at the commencement and a loop of the suture is tied to the single end (see Fig 149, D and E) This completes the first row which however would be inefficient in preventing a leak and requires to be

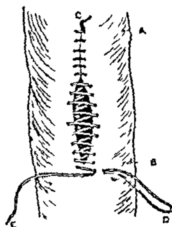


Fig 149 —Suture of wound of intestine First line

A Commencement of wound of intestine to be sutured B end of wound C a knot of thread D a loop E a single end It is best to make a single knot at intervals in the line The suture is completed by tying D and E together and cutting off their ends



Fig 150.—Mattress suture of intestine (Connell s method)

The continuous suture traverses all the coats of the intestine from within It is obvious that this suture does not bring the mucous membrane of the two segments evenly into contact but leaves a raw edge facing the lumen all round

reinforced by the second row, which consists of Lembert s sutures either continuous or interrupted For the second row a straight needle is preferred by many its even passage is assisted by slight traction being made on the line by means of the thread ends of the first row

2 **The interrupted suture** *Lembert's suture*—The needle is passed transversely to the line of the wound and at right angles to the axis of the bowel

A fold is picked up upon one side of the wound the needle is then carried over to the corresponding spot on the other side of the wound where a precisely similar fold is picked up (Fig 148) The margins of the wound are turned in and the serous coats are brought into close contact The needle should pick up more than the serous coat it should include a part or the whole of the muscular coat also It must on no account trespass beyond the limits of the submucous layer

The width of the fold picked up will be from one tenth to one twelfth of an inch

The closeness of the sutures to one another must vary somewhat according to circumstances They may be usually estimated at about ten to the inch It will rarely be safe to apply them less closely than this As shown in Fig 148 a number are inserted before any are tied

Much trouble is saved and the inconvenience of a long wet and sticky thread is avoided if separate threaded needles are prepared for each suture This applies much more to catgut than to Japanese silk The time taken in introducing and tying a series of interrupted Lembert s sutures is about halved by making them of the mattress variety now to be described

The mattress suture—This is a very useful method of securing firm apposition and may be employed in both rows the first which traverses all the coats (the hæmostatic suture) and the second a reinforcing Lembert one It is simply a quilt suture which takes a firm hold of the intestinal wall by passing for a short distance through the tissues *parallel* with the edge of the wound before crossing to the opposite side Description of it will be saved by referring to Fig 148 This mattress or quilt suture may be either continuous or interrupted We have found it apt to tear through the tissues when used in the continuous form in the outer row and therefore do not strongly recommend

it here but this cannot occur when it is used through all the coats (Connell's method, *see* Fig 150) and its only drawback is that it produces marked infolding of the wall and does not bring the *mucous membrane* on either side into such even contact as the ordinary continuous one, though it is probably safer as regards risk of leakage

Instead of using either of the above methods for the second or outer row, the operator may employ a *continuous* Lembert stitch, the details—except in the important point of not including the mucous membrane—are precisely the same as those given for the first row (*see* p 328) This is practically always done in gastro jejunostomy and the many other forms of anastomosis Directly the suture line is supposed to be water and air tight the clamps above and below are removed If a weak spot in the union is detected, it must be reinforced by one or two Lembert's sutures There need never be any fear about turning in the intestinal wall too much in dealing with the usual incisions in the long axis of the gut

The method detailed above—the double line of suture, one through all the coats the other a Lembert's through the outer ones only—has a very wide application It holds good for *gastro jejunostomy* as well as for *lateral anastomosis* of both large and small intestine But in these operations for anastomosis the Lembert's suture is made first close to the line selected for the communication, after the *suture has passed along one side of this line the opening is* made in the two portions of the alimentary tube The margins of these openings, exactly corresponding in length, are then sewn together with the continuous suture which includes *all the* coats *Finally the Lembert's suture* is resumed so as to surround the wound Moynihan's loop on the mucosa stitch passes through all coats of the bowel, from peritoneum to mucosa and back again from mucosa to peritoneum on one *side* of the anastomosis it is then inserted in the same way through all the coats on the other side of the anastomosis, and drawn tight This draws together and inverts the divided edges of the gut and makes the suture line extremely neat

2 **The interrupted suture** *Lembert's suture*—The needle is passed transversely to the line of the wound and at right angles to the axis of the bowel

A fold is picked up upon one side of the wound the needle is then carried over to the corresponding spot on the other side of the wound where a precisely similar fold is picked up (Fig 148) The margins of the wound are turned in and the serous coats are brought into close contact The needle should pick up more than the serous coat it should include a part or the whole of the muscular coat also It must on no account trespass beyond the limits of the submucous layer

The width of the fold picked up will be from one tenth to one twelfth of an inch

The closeness of the sutures to one another must vary somewhat according to circumstances They may be usually estimated at about ten to the inch It will rarely be safe to apply them less closely than this As shown in Fig 148 a number are inserted before any are tied

Much trouble is saved and the inconvenience of a long wet and sticky thread is avoided if separate threaded needles are prepared for each suture This applies much more to catgut than to Japanese silk The time taken in introducing and tying a series of interrupted Lembert's sutures is about halved by making them of the mattress variety now to be described

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CHAPTER III

RESECTION OF THE INTESTINE

UNDER this title are included operations concerned with the removal of comparatively small portions of either the small or the large intestine

Excision when applied to the lesser bowel is termed enterectomy and when carried out in the colon colectomy

The details of the operation will be considered under the following headings —

1 Enterectomy with circular suturing of the divided ends—end to end union
2 Closure of the ends with side to side anastomosis
3 Insertion of small intestine into the large gut—end to side union
4 Enterectomy with the establishment of an artificial anus
5 Colectomy

I ENTERECTOMY WITH CIRCULAR SUTURING OF THE DIVIDED ENDS

1 The abdomen having been opened the first step is to isolate the loop of intestine to be excised This loop should be drawn well out of the parietal wound Any adhesions which prevent it from being well exposed and isolated must be divided

If any extravasation has taken place into the abdominal cavity it should be dealt with before the resection is commenced

The part to be resected is placed upon a warm moist swab or small towel and the whole wound through which

It is not hæmostatic however, and is therefore not to be recommended

Nothing has been said as to the arrest of hæmorrhage from the wound in the intestine etc When the incision is being made if any large vessel is seen to be divided it should be picked up with Wells s forceps and ligatured Otherwise the suture suffices This should be drawn sufficiently tightly together to secure approximation of the parts and to effect hæmostasis but not tight enough to strangle the tissues enclosed

the mesentery on approaching the mesentery care must be taken to save as much of that membrane as possible

Another—and in most instances a better—method of treating the mesentery consists in excising a triangular portion of the membrane together with the gut to be removed The base of the triangle will be at the intestine but will be narrower than the length of bowel removed By allowing the mesentery to overlap the divided ends as it were the vascular supply of these segments is the less interfered with The margins of the wounds in the mesentery are then carefully brought together by a continuous suture

4 The divided ends of the bowel are now thoroughly cleansed and all soiled sponges are removed and replaced by fresh ones

The mucous membrane may be found to protrude considerably and to appear to interfere with the proper adjustment of the sutures As a rule it is unnecessary to cut any of this membrane away The two ends are placed in close apposition and maintained there by the assistant who steadies the clamps

The suturing should now be done in the manner described on p 328 A double row is employed one through all the coats (either by Connell s method or the simple continuous suture) the second through the outer coats only (Fig 150)

The surface sutures will be applied according to Lembert s method and in the manner already described

The weak part of the suture line will be at the mesenteric border It is at the line of the attachment of this membrane that the first stitches are applied Use must be made of any peritoneum which has been saved from the mesentery and sufficient must be found to serve as a covering for the bare portion of the bowel Not only must the muscular coats be well brought together at this part but inturned flaps of peritoneum covering that coat must also be brought into direct and close contact After the bowel is united at the mesenteric attachment it is a good plan to pass a separate single suture through the middle of the free border of the intestine i e exactly opposite the mesenteric suture This

the intestine has been drawn is well and carefully packed all round with similar material It should be impossible for any intestinal matter to find its way into the peritoneal cavity

2 The bowel must be occluded above and below the resection area If sponges have been well packed all around the coil, this precaution may sometimes and in some special cases be dispensed with

As a rule metal clamps covered with rubber will be found advisable But if they are not at hand the fingers of an intelligent assistant answer as a substitute and probably do the least harm to the intestinal wall If clamps are applied they should be removed at the earliest possible moment

In adjusting clamps the upper one will be applied first The segment of bowel to be excised will then be gently emptied by passing the fingers along it and the lower clamp will be fixed in position Little matter should therefore escape from the isolated segment during the division of the coats of the bowel Any risk of this may be prevented by applying two more clamps on the loop to be excised each of them a short distance from the first pair the section is made between each pair of clamps Before applying the sutures, care must be taken that the bowel above the resection area is not greatly distended If it be so the distension must be relieved as much gas and fæcal matter being allowed to escape as will find an exit This is best effected by making an opening in the centre of the loop to be excised and allowing the intestinal contents to escape into a gutter of thin indiarubber tissue which has been already prepared and put in position This answers better than the method of loosening the upper clamp after the bowel has been excised

3 The portion of diseased bowel is now excised and removed with its clamp attached This is effected with blunt pointed scissors The cut must be made about three fourths of an inch beyond the margin of either clamp If it be much nearer it will be found that the clamp interferes with the movement of the needles during the passage of Lembert s suture

The scissors cut their way from the free border towards

prefer it under all conditions to end to end union and although it will probably take more time to effect, they consider it to be the safer method

The most rapid way of performing it is the following

1 A short distance beyond each clamp (i e on the distal side of the upper clamp and the proximal side of the lower one) apply a crushing-clamp and tighten it up remove, and pass a silk ligature round in the groove made by the crushing Tie this circumferential ligature and cut away the affected portion of intestine

2 Attend to the mesenteric vessels

3 Remove the clamps enter a purse string suture (Lembert s) round each blind end invaginate the crushed and tied portion tighten up and knot the purse string suture

We have now two closed portions of intestine

Gently squeeze away the contents in each so that the clamps can be again applied 4 or 5 inches from their blind ends

4 Place the two clamped portions side by side some distance from their mesenteric attachments unite them together by a continuous Lembert s stitch for a line about 3 inches in length Parallel to this line open the two portions of gut with cutting instruments for at least 2 inches

Sew all round this opening the suture traversing all the coats

A free communication between the two (formerly blind) portions has now been made at or near the free border of the intestine

Complete the Lembert s suture

Thus the hæmostatic suture is completely buried from view

Look over the junction and reinforce if necessary with two or more interrupted Lembert s sutures

Remove the clamps gently wash with warm water return the bowel within the abdomen and sew up the wound in the abdominal wall

Comment —In side to side union it might be thought that the mesentery of the two ends would offer difficulties it is of course folded slightly Further the passage of

suture may be used for slight traction and will facilitate the even approximation of the edges all round

When the whole circumference of the gut has been secured by the double row of sutures the surgeon next turns to the mesentery If a triangular portion has been removed the margins of the gap are brought together by several points of suture—or better still by a continuous suture (Fig 151)

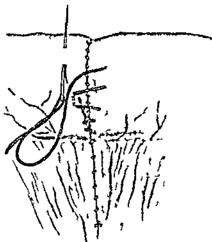


Fig 151 —End to end anastomosis of intestine showing the insertion of the peritoneal layer of sutures which also has closed the gap in the mesentery

5 The bowel is well cleansed with warm water the sponges that have held the coil in place are removed and the sutured loop is allowed to drop back into the abdomen The abdominal wound is then closed and unless distinct reasons exist to the contrary no drainage tube is introduced

II CLOSURE OF THE INTESTINAL ENDS WITH SIDE TO SIDE UNION

This is especially applicable if the proximal part of the gut is much more dilated than the distal one Some surgeons

prefer it under all conditions to end to end union and although it will probably take more time to effect they consider it to be the safer method

The most rapid way of performing it is the following

1 A short distance beyond each clamp (i e on the distal side of the upper clamp and the proximal side of the lower one) apply a crushing-clamp and tighten it up remove, and pass a silk ligature round in the groove made by the crushing Tie this circumferential ligature and cut away the affected portion of intestine

2 Attend to the mesenteric vessels

3 Remove the clamps enter a purse string suture (Lembert s) round each blind end invaginate the crushed and tied portion tighten up and knot the purse string suture

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Complete the Lembert s suture

Thus the hæmostatic suture is completely buried from view

Look over the junction and reinforce if necessary with two or more interrupted Lembert s sutures

Remove the clamps gently wash with warm water return the bowel within the abdomen and sew up the wound in the abdominal wall

Comment.—In side to side union it might be thought that the mesentery of the two ends would offer difficulties it is of course folded slightly Further, the passage of

intestinal contents is not so direct as after end to end union On the whole there does not appear to be any great difference in final results or in the proportion of recoveries

During the two World Wars opportunities were afforded for testing the comparative safety and value of the two methods such as had never before occurred For gunshot wounds of the abdomen resection of portions of intestine became a frequent operation At one time end to end union was most in favour then side to side and finally surgical opinion veered again towards the former method

For strangulation in hernia end to end union appears to be the most successful and on the whole the most generally performed

LATERAL ANASTOMOSIS WITHOUT RESECTION

It will be convenient here to describe this method although the intestine is not resected at any rate at the primary operation It corresponds closely to gastro jejunostomy as applied to the intestine and is of value in giving relief to obstruction by a tumour or stricture etc though its scope is limited and its efficacy uncertain It is used to make a fistulous opening between two loops of small or large intestine or between one and the other

The two pieces of intestine which it is intended to join together are drawn out of the abdominal wound and supported by warm sterilized compresses or flat sponges The contents are expelled by gentle pressure and clamps applied above and below the site of anastomosis The free surfaces of either piece of intestine are turned towards each other and it is ascertained that they can be easily made to lie in contact and that the clamps do not interfere with this On the convex surface of each intestinal loop a continuous suture of fine catgut which traverses the coats down to the submucous layer is passed and tied at either end The suture follows the axis of the intestine Just in front of this the intestine is opened for about 2 inches by a longitudinal incision made with a tenotomy knife or fine scalpel and enlarged with fine scissors Any fluid contents which have remained

after clamping are wiped away A continuous suture—fastened off at short intervals by knots—is then carried through the whole thickness of the circumference of the wound on either side Finally a continuous suture is passed through the outer coats of the intestine in front of the anastomotic opening The clamps are removed as soon as possible a few Lembert s stitches are applied wherever it seems advisable and the loop is returned into the abdomen after gentle cleansing

Later on it may be desirable to perform a second and more radical operation with resection of the diseased portion and closure of the ends

III Insertion of Small Intestine into the Large —End to Side Union

This may be illustrated by two different procedures The first where the intervening portion of gut has been excised is the more satisfactory of the two After excision of the whole cæcum ascending colon and hepatic flexure the right half of the transverse colon is closed by the usual double row of sutures Of course the level of excision will entirely depend on the extent of disease About 2 inches beyond the closed end a vertical slit is made in the long axis of the colon opposite to the attachment of its mesentery large enough to admit the divided end of the ileum which so far is held closed in a clamp The position of this clamp is important it must allow a free portion to project beyond it *sufficient to give room for suturing before the clamp is removed* Taking every care to prevent escape of the large intestine contents the ileal end is quickly invaginated through the slit so as to project within the lumen and a line of suture carried quickly all round The remaining clamp can now be removed and a second line of Lembert s sutures is made to reinforce the first The mesentery will need some attention care must be taken to ligature all possible bleeding vessels and to leave no aperture in this membrane

The second example is afforded by ileo sigmoidostomy

where the ileum is implanted into the sigmoid flexure and the whole of the colon between the cæcal valve and the point of communication is "segregated"—at any rate for a time for the intestinal contents will regurgitate backwards and a second and more serious operation (excision of the whole

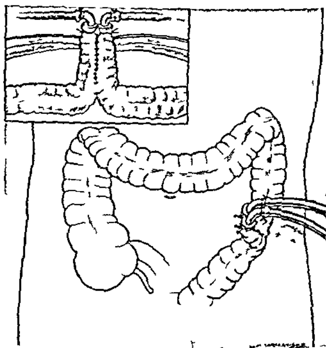


Fig 152—Paul's operation for carcinoma of the sigmoid colon Inset method of suturing the colon and the introduction of the Paul's tubes

colon) will probably be required After this second operation troublesome adhesions are sure to form among the small intestines Hence ileo-colostomy may open for the patient a lengthy programme of successive abdominal operations One must also note that it has been advocated and performed

too widely sometimes in unsuitable cases and for conditions which were not likely to be cured thereby

The operation —The abdomen is opened through a left rectus incision—paramedian or through the outer part of its sheath—and the extreme end of the ileum looked for and doubly clamped near the cæcum leaving sufficient room between the clamps for the application of the crushing ones The clamps are applied obliquely so as to allow the maximum amount of blood to reach the portion of the ileum which is to be anastomosed The short distal portion after crushing (this is of course not indispensable as a double row of sutures will be as effective) is closed with a purse string suture

The proximal end is now inserted into the sigmoid flexure

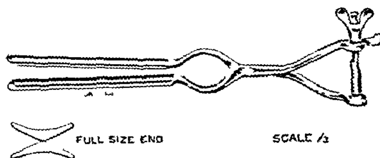


Fig 153 —Enterotome employed in Paul s operation

in a similar way to that described in the case of the ascending colon (p 339) but much more trouble is required in connexion with the mesentery The divided part of this membrane must be carefully sewn to the adjacent surface of the colon so that no raw surface and especially no aperture is left through which an internal hernia might subsequently develop Many unfortunate instances of this occurred before its danger was appreciated

During the operation as in all lengthy abdominal operations saline infusion should be given intravenously and before closing the abdominal wound a pint of saline may be poured into the cavity

IV ENTERECTOMY WITH THE ESTABLISHMENT OF AN APTIFICIAL ANUS

This is especially indicated when a tight obstruction such as a ring carcinoma of the large intestine has led to great dilatation of the upper part In such cases it is dangerous to attempt immediate union of the divided ends after two or three weeks the bowel will have contracted so that the operation can be completed by secondary union The fir t part consists merely in bringing out the obstructed loop in clamping above and below, in resection wide of the ob struction between the clamps and in securing the divided vessels

The removal of a triangular piece of the mesentery facili tates the subsequent closure of the artificial anus The gap left in the mesentery should be united by suture as described

After the excision has been carried out the wound in the parietes is so far closed as to leave only a gap through whi h the divided ends of the gut project The two sections of bowel —still clamped—should be brought together by their mes enteric borders and united by a few points of suture If time and the condition of the patient allow the union of the two ends may be carried a littl to either side of the mes enteric border The mucous membrane over the uniting isthmus should be brought together by a simple continuous suture This partial union of the gut greatly facilitates the operation for the subsequent closure of the fæcal fistula

The lower end of the divided bowel is now rapidly united to the parietes The margin of the bowel is secured all round to the margin of the parietal wound The serous covering of the intestine must be brought into contact with the serous lining of the abdominal wall

The main sutur s may be passed before the clamp is removed and may be drawn tight and secured when the clamp is withdrawn

The upper end of the bowel is dealt with in the same way Every preparation must be made for a rush of fæcal matter as soon as the upper clamp is removed The main sutures

will be in place before the clamp is withdrawn The intestinal contents may be received upon a layer of oiled lint which is frequently changed

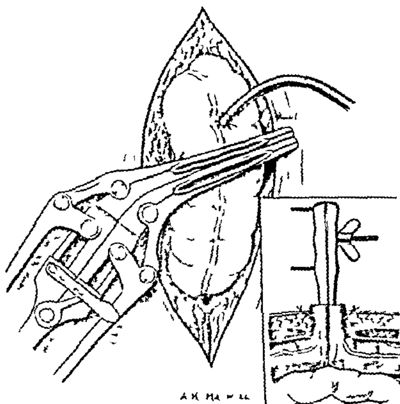


Fig 154 – Resection of carcinoma of the colon (Rankin's method)

More satisfactory is the modification of this operation as evolved by Paul and Mikulicz The bowel is divided between clamps and the divided ends are brought out of the wound The adjacent sides of the upper and lower segments are united

by suture and the wound is closed A Paul s tube is tied into each opening (Fig 152) At the end of three or four days an enterotome is applied to the spur between the two loops

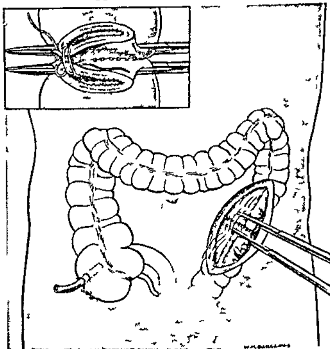


Fig 155 —Excision of growth in the sigmoid colon and end to end union This is only possible after a preliminary cæcostomy Inset method of suture of the bowel

and gradually tightened causing the spur to disappear (Fig 153) Subsequently the fistula is readily closed

Rankin has devised a modification of this operation in which the growth bearing segment of bowel with its mesentery is mobilized the blood supply is ligatured and the whole segment is resected over a three bladed clamp (Fig 154) ... much obstruction a catheter can be tied into the limb of the bowel just in front of the clamp By this

means an outlet is provided for the passage of gas and fæcal contents and the wound is allowed to heal soundly The

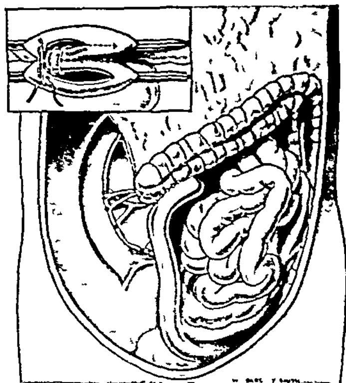


Fig 156 —Partial colectomy for carcinoma of the cæcum. Inset method of suture

The terminal ileum, cæcum, ascending colon and hepatic colon have been removed and the ileum joined to the transverse colon by a lateral anastomosis.

catheter is placed in the bowel after the abdomen has been closed

Note —Although cancer of the large intestine often occurs in the sigmoid colon it is rarely found practicable to bring out the loop as described above When intestinal obstruction is present in such a case the only alternative is

by suture and the wound is closed A Paul's tube is tied into each opening (Fig 152) At the end of three or four days an enterotome is applied to the spur between the two loops

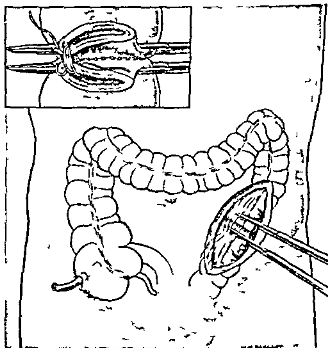


Fig 155 —Excision of growth in the sigmoid colon and end to end union This is only possible after a preliminary cæcostomy Inset method of suture of the bowel

and gradually tightened causing the spur to disappear (Fig 153) Subsequently the fistula is readily closed

Rankin has devised a modification of this operation in which the growth bearing segment of bowel with its mesentery is mobilized the blood supply is ligatured and the whole segment is resected over a three bladed clamp (Fig 154) If there is much obstruction a catheter can be tied into the proximal limb of the bowel just in front of the clamp By this

CHAPTER IX

COLOSTOMY AND ENTEROSTOMY

These operations are sometimes termed colotomy and enterotomy but as they imply not merely cutting into the bowel but maintaining the opening for a considerable time if not permanently the terms here used are more correct

As a rule the colostomy is made in cases of malignant obstruction of the large intestine and here iliac or transverse colostomy is the operation of choice Of course the opening must be made above and at some little distance from the site of the tumour which may perhaps have been previously felt In chronic cases the exact position of the obstruction can usually be ascertained by the aid of barium and the X rays (note that the constriction in itself does not in many cases form a tumour it may be just as if a string had been tightly tied round the gut) In acute cases of obstruction when time does not allow of such investigation the site is determined by a paramedian exploratory incision which should be as short as circumstances allow This is sewn up and a fresh incision made for the colostomy

Making an opening in the cæcum may be necessary but it has several drawbacks and should be avoided if possible The contents of the cæcum are more fluid and more irritating than those of the transverse colon The formation of a small aperture in the cæcum for purposes of irrigation and the use of the vermiform appendix with the same object stand on a different footing they will be described later

An opening made in the ileum is an occasional emergency measure also described in this chapter

to make a colostomy some distance up the gut (perhaps using the transverse colon for this purpose) through another wound After the bowel has been thoroughly emptied and has recovered its previous condition resection of the cancerous part with end to end union may be performed and if all goes well a third operation for closure of the colostomy can be undertaken Severe as this procedure involving three operations at intervals may seem it has often given excellent results

V Colectomy

Under this heading may be included a variety of operations the most simple being excision of a segment of the transverse colon or the sigmoid with end to end union (Fig 155) The procedure which must not be undertaken whilst obstruction is well marked, corresponds closely to that described for excision of part of the small intestine The cæcum affected with new growth may be excised with more or less of the ascending colon, and the end of the ileum implanted into the remaining part of the latter Thirdly the whole of the colon down to its pelvic portion is sometimes removed the ileum being joined on to the rectal stump

It is unnecessary to describe here all the details of such operations the technique of which may in the main be inferred from what has been already given

(i) *Without Skin Bridge*

Indicated in those cases in which it may prove possible later to allow closure.

The skin incision and opening in the abdominal wall is made at the same site and in the same manner as a Terminal colostomy. *A loop of sigmoid colon* is then drawn through the wound so that the mesentery is exposed. A glass rod is inserted through the mesentery and the ends of the rod united by a loop of rubber tubing which encircles the bowel (Fig. 157); this remains for 10–14 days. The bowel can therefore not slip back into the abdomen. The appendices epiploicae in the loop should be ligatured and cut off close to their bases since they become oedematous and a nuisance if they are left. It is important that the loop of sigmoid used should be as near the descending colon as possible so that torsion of the loops or prolapse of the proximal loop does not occur; also any operation distal to the colostomy is made much easier. The peritoneal edges are united to the sero muscular coat of the loops with catgut sutures and the wound sealed with vaseline gauze dressings.



Fig. 157.—Left iliac colostomy.
A glass rod has been placed beneath the colon.

(ii) *With Skin Bridge*

The skin incision is made at the same point as for the Terminal colostomy. A V shaped incision is made with the long axis of the V lying along an imaginary line joining the anterior superior iliac spine and the umbilicus, the apex of the V pointing upwards and inwards. The flap of skin is raised with the underlying subcutaneous tissue. The operation is then completed as for the loop colostomy without skin

Lumbar colostomy is now so rarely performed that details of its performance may be omitted

Left Iliac Colostomy

This may be performed as a Terminal Colostomy or as a Loop Colostomy

(a) *Terminal Colostomy*

Such a colostomy is indicated when the rectum is removed and its performance is part of the routine Abdomino Perineal or Perineo Abdominal operation which is performed in one stage (*See* Abdomino Perineal Excision of the Rectum p 192)

When the sigmoid colon has been divided an elliptical area of skin 1 in long and ¾ in at widest diameter is excised at a point 1½–2 in medial to left anterior iliac spine along an imaginary line extending from that bony point to the umbilicus The long axis of the ellipse should be obliquely A stab incision is now made into the peritoneal cavity with two fingers of the left hand inserted through the laparotomy wound to guard the entry of the knife into the abdominal cavity Two fingers are then inserted into the wound which is enlarged The peritoneal edges are picked up in four places with hæmostats and the proximal end of the sigmoid colon closed by the de Martel clamp is drawn through Four stay sutures of catgut are inserted to unite the peritoneal edge and the serous coat of the bowel as it passes through The wound is then sealed off with petroleum jelly gauze dressings

To avoid the complication of internal strangulation of small bowel by its passage along the left paracolic gutter a purse string suture of catgut is used to unite the sigmoid colon as it passes from the posterior abdominal wall to the colostomy wound and the peritoneum on the lateral aspect of the paracolic gutter

(b) *Loop Colostomy*

i Without skin bridge where it is to be a temporary colostomy

ii With skin bridge where it is to be a permanent colostomy

intestine a purse string suture of silk is placed circumscribing an area of six an inch in diameter In this area a linear opening is made the edges are held aside by fine toothed forceps and the glass tube is introduced The tube is so placed that its lumen is directed upwards i e facing the proximal part of the gut and the silk suture is firmly knotted round the groove on the tube A thin rubber tube some few feet in length should already have been fixed to the other end of the glass tube through which the intestinal contents may pass into a covered jar containing a disinfectant Or the rubber tube can be dispensed with—it tends to pull the glass tube out of place The wound can be kept absolutely clean and the neighbourhood of the patient free from odour until the tube comes away The insertion of the glass tube which should be large enough to allow semi solid fæcal matter to pass through it may be effected so quickly that no leakage occurs before the silk is tied The tube is supported in position by a thick pad of gauze and wool around it this dressing is held in place by bandage A cradle is used to keep off the weight of the bed-clothes and the rubber tube if used may be conveniently attached to the side of the cradle and so carried out of the patient s bed

Provided the glass tube does not get blocked it may be left to come away by itself which usually happens some four or five days after its insertion It must however be admitted that the tube is apt to fail to allow the fæces to drain through it and in some cases has to be cut away

Transverse Colostomy

Making an opening in the transverse colon through a short paramedian incision is a good substitute for sigmoid colostomy The transverse colon normally lies behind the abdominal wall about the umbilical level but is apt to sag farther down It is usually easy to bring through the wound the great omentum having to be slightly divided (with care as to hæmorrhage) if a well marked spur is to be made The other steps are the same as in iliac colostomy without skin bridge

bridge except that before the glass rod is inserted through the mesentery, the skin flap is pulled through and the apex sutured back into place The glass rod is then inserted and the operation completed

The surgeon now decides whether or not to open the intestine at once

1 If there has been no distension of the abdomen before the operation the opening may be deferred for three or four days In that case gauze soaked in sterile paraffin to facilitate subsequent removal is packed round and over the protruding loop, and a pad of cotton wool kept in position outside this by a bandage or binder A moderate dose of morphia or an opiate should be given the same evening if there is pain or restlessness At the end of three or more days the intestine will adhere firmly to the wound and may be opened without giving an anæsthetic The opening may be made either with scissors or the actual cautery If redundant intestinal wall be cut away the arteries bleed freely and should be clamped with forceps or tied with silk The intestine seems to project unduly for a time but it settles down Many surgeons divide the gut completely across The incision of the intestine is almost painless

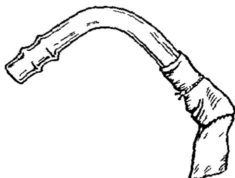


Fig 158 —Paul s tube for colostomy or enterostomy
(About half size)

The tube is made in three sizes The commencement of the rubber tube is shown tied to the glass tube by a silk thread

2 If it be decided to complete the colostomy whilst the patient is under the anæsthetic a Paul s tube of suitable size may be inserted (Fig 158) On the convexity of the

PARAMEDIAN COLOSTOMY

In this operation a paramedian incision is made just below the umbilicus This is extended upwards to encircle the umbilicus (Fig 159 A) which is then completely excised and the anterior sheath of the left rectus muscle opened The muscle itself is retracted outwards the posterior sheath incised and the peritoneal cavity opened (Fig 159 B) The abdominal contents are examined and the liver palpated for secondary growths The same incision is made in all cases whether the rectum is excised or not The loop of the sigmoid colon is found and brought through the incision Clamps are placed at the upper and lower ends of this loop (Fig 159 C) and the intervening piece of gut is incised The lower clamp is kept on the gut while the parietal peritoneum is joined to the peritoneal coat of the gut A purse string suture is inserted below the upper clamp and a piece of rubber tubing is passed into the cut surface of the bowel when the clamp is removed The purse string suture is then tied and so secures the rubber tubing inside the colon The edges of the posterior sheath of the rectus are sutured and the rectus muscle is allowed to fall back into its place The anterior sheath is sutured around the two ends of the colon and the skin is then approximated (Fig 159 D) The lower clamp is retained *in situ* for three or four days by which time the crushed area is probably necrosed The tube in the upper end of the sigmoid generally comes away after a week and the colostomy works of its own accord The skin stitches are removed on the eighth day when the wound will be soundly healed

CÆCOSTOMY

This is usually performed either for intestinal obstruction or in order to allow irrigation of the colon The opening need only be large enough for the passage of a rubber tube (the size of a large catheter) A muscle splitting incision is made in the right groin as for appendicectomy (Fig 146) and a purse string suture is passed through the outer coats of the saccular lower end of the cæcum this suture surrounds a small circular area in which a short

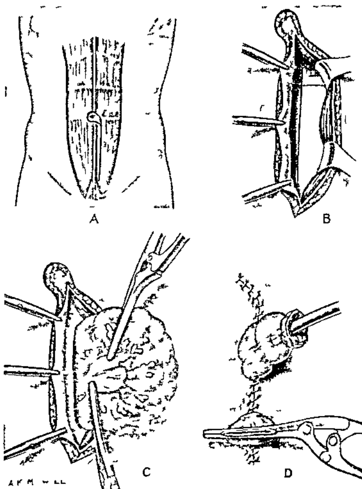


Fig 159 —Stages in the operation of paramedian colostomy

A Ski l l lon en los g tl ml l u B Spl tti g the rectus muscl and opening th post r o w ll f tl r ctu sh th C Excl i of a loop of sigm id c l n D (l t my inpl t d tu! l tl d l to tle proxim l p tio of the igm id c l b l a clamp is left on th di t l part of the igmold olon

the latter to the cæcum An additional suture or two may be added for the same purpose if thought necessary, and the small abdominal wound is closed

Enterostomy

When operating on an acute intestinal obstruction the surgeon may decide that the only justifiable measure is to relieve the distension and to drain the intestine by opening the first coil of small gut that presents itself This usually belongs to the lower ileum The coil is not drawn outside the wound but secured to its edges by a few sutures A small sized Paul's tube is secured by a purse string suture through the linear aperture The rest of the wound is closed and a light gauze dressing applied If the patient survives—the operation must be regarded almost as a forlorn hope—and the Paul's tube comes away care must be taken to keep the edges of the wound covered with aluminium paste or some similar ointment to prevent irritation of the skin Very frequent dressing will be required

It is possible that once the obstruction has been relieved by enterostomy the patient's condition may so far improve that a second and more thorough operation can be undertaken if so the shorter the interval the better

Appendicostomy

This is sometimes still used as a measure to irrigate the large bowel in ulcerative colitis

A gridiron incision is made and the appendix brought to the surface A suture is passed seromuscularly at its base and another through the mesentry These are sewn to the parietes so as to anchor the organ (Fig 160) The wound is then closed and the appendix amputated about ½ inch above skin level The end may be split and everted and a catheter is readily passed into the cæcum The procedure may be performed under local anæsthesia When requiring closure the base of the appendix is removed and the stump invaginated into the cæcum as in formal appendicectomy (Fig 162)

linear incision is made through the cæcal wall to admit the tube

The end of this tube (or if preferred a "self retaining catheter" with expanded extremity) is inserted within the gut the purse string suture is drawn taut and tied sufficiently

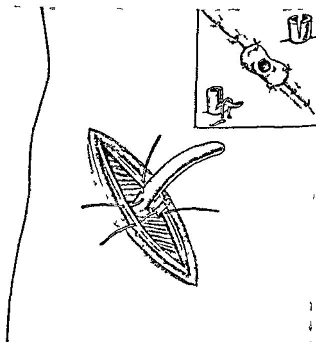


Fig 160 —Appendicostomy showing method of securing the appendix Inset the final result

tightly to prevent escape of contents alongside the tube The ends of the suture are cut short A second purse string suture a short distance outside the first may be used to invaginate the cæcal wall exactly as in gastrostomy (p 363) This latter suture being tied its ends are threaded on separate needles and passed through the abdominal wall to fix

In most cases the appendix has a distinct mesentery in which runs its artery—the termination of the ileo-colic. This mesentery (meso appendix) when present is always derived from the posterior surface of that of the ileum

In some instances the appendix is tied down to the iliac fossa Its average length is 3½ inches but it may be as short as half an inch or as long as 6 inches

The retrocæcal appendix is a most important one from the operator's point of view it may be comparatively free in a retrocæcal pouch of peritoneum but much more frequently it is tied down and *may have no peritoneal covering whatever* Partly on this account, its removal may present extraordinary difficulties

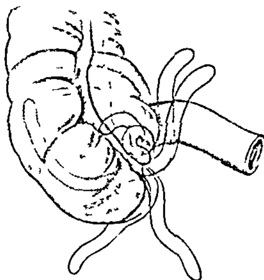


Fig 161 —Various positions in which the appendix may be found

The appendix is supplied with blood by the posterior cæcal artery a vessel which passes behind the end of the ileum to reach its destination The artery to the appendix enters the meso appendix and divides into three branches The largest runs in the free edge of the meso appendix and reaches the tip of the vermiform process The other two reach the appendix at intervals of about half an inch

The incision—The incision from 2 to 3 inches long is made obliquely across the line which joins the anterior superior iliac spine and the umbilicus crossing this line

CHAPTER V

REMOVAL OF THE VERMIFORM APPENDIX

The most favourable time for this operation is at the commencement of an attack of appendicitis i e in the first twenty four to thirty six hours after the onset of symptoms or during a quiescent period when symptoms of inflammation have subsided (though the appendix itself often shows marked evidence of this being still present)

The commonest position of the appendix is behind the cæcum The following table shows its relative positions in a series of 5 000 cases * (Fig 161)

Position of appendix	No of cases	Per cent
1 Anterior or pre ileal	47	0 94
2 Splenic or post il al	25	0 5
3 Pelvic on psoas mu cle near or hanging over the brim of the pelvis	1606	32 11
4 Subcæcal beneath the caput cæci	101	2 02
5 Post cæcal and retrocolic	3219	64 38
6 Ectopic	2	0 04

The following account refers to appendicectomy uncomplicated by the pres nce of an ab cess

* Cecil Wakeley *Lancet* 10.8 1 178

terminate in the appendix If both these guiding rules are followed it must be very rare for the operator to be baffled in his search However, occasionally the cæcum itself is absent from the iliac fossa (through arrest of its descent), and the surgeon finds only transverse colon and small intestine The separation of the adherent appendix is often tedious As already noted, if retrocæcal, its peritoneal investment may be absent, and it may adhere to the colon in its whole length Care must be taken in clearing it off the iliac vein and the ureter Special care is necessary when the ileum is closely involved in the adhesions The adherent appendix may open by one or more ulcerations into the cæcum, colon ileum, or rectum, and the apertures left in these viscera by the removal of the appendix must be carefully closed The appendix is often adherent to the ovary or broad ligament and occasionally it is attached to the bladder It has been known even to open into the interior of the bladder The diseased structure may be buried in a mass of omentum or may be closely united to the mesentery or be buried in dense and almost cartilaginous tissue in the iliac fossa It may extend upwards and its tip be found under the liver or even adhering to the right kidney or to the gall bladder A large proportion of the adhesions encountered are dealt with by the fingers There must be no tearing, and no dragging of tissues apart with two pairs of dissecting forceps The blunt dissector is often useful All resisting adhesions should be well defined, then cut with scissors or a scalpel. In all these preliminary measures the operator should observe the rule to keep close to the appendix and above all seek for its tip The free end of the appendix is the key to the position when adhesions are very troublesome When once that is found the difficulties are nearly over

In many cases of difficulty we have divided the undisturbed peritoneum of the right iliac fossa well to the outer side of the disturbed area and by working along in the retroperitoneal tissue have reached the adherent bowel and have readily detached it stripping off the peritoneum with it The operator should never drag upon adherent bowel especially

about 1½ inches above and to the inner side of the iliac spine The external oblique is divided in the line of its fibres the edges of the aponeurosis are then caught with Wells's forceps or held by blunt hooks and retracted Mainly by blunt dissection the fibres of the subjacent internal oblique and transversalis are separated at right angles to the incision through the external oblique These two muscles are retracted in the same way, and the transversalis fascia and peritoneum next dealt with The peritoneum is divided with care as the cæcum ileum or omentum may be adherent to the anterior abdominal wall at the point of the incision The divided peritoneum on either side of the wound is neatly picked up with four pairs of Wells's forceps as these are drawn upon they act as retractors and facilitate the introduction of the fingers into the abdomen Two fingers of the right hand are passed into the cavity and the cæcal region is examined In the female subject this examination should always include the right ovary

This approach to the appendix may be employed only when there can be no reasonable doubt that the diagnosis is uncomplicated appendicitis or appendix abscess It does not permit of an examination of the stomach duodenum or gall bladder and if the slightest suspicion falls upon any of these organs as well as upon the appendix then a right paramedian incision must be employed

Demonstrating the appendix — The cæcum is sought for and is gently drawn out of the wound by means of the two fingers As a rule this is readily done when there are no adhesions and in such case the appendix is at once demonstrated In a large proportion of cases however there are difficulties due to adhesions The whole area should be well examined with the fingers and the wound enlarged if necessary The simplest way of finding the appendix is to identify the cæcum and the terminal part of the ileum in the lower angle of the junction of these two the appendix will be found Another guide which is more often given, though not nearly so useful as the above is to trace downwards one of the longitudinal bands on the cæcum—they must

then divided, after which ligatures are carefully applied below the forceps When the appendix is adherent the adhesions are dealt with similarly and the organ about to be removed is entirely freed from its blood vessels

Removal of the appendix (Fig 162)—The base of the appendix is crushed by two artery forceps one is placed across the appendix exactly at the point where it enters the cæcum and the other is applied immediately distal to this The first forceps is removed and discarded and a catgut ligature firmly tied around the crushed area A purse string

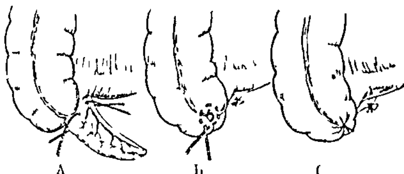


Fig 162 —Removal of the appendix

A Appendix crushed and tied meso appendix also tied B C Stages in invagination of stump of appendix with purse string suture

suture is inserted in the wall of the cæcum around the base of the appendix and the ends of the suture are left long and untied The appendix is now divided with a carbolized knife between the ligature at its base and the remaining pair of forceps The knife is discarded The small stump of appendix is invaginated into the wall of the cæcum by means of a pair of sinus forceps and the purse string suture is drawn tight The sinus forceps is then discarded

The ligatured meso appendix is again examined to make sure that hæmostasis is perfect and the cæcum is returned to the abdomen

Closure of the wound — Small blunt hooks are introduced into the ends of the wound and by means of

upon adherent ileum The only structure upon which con siderable traction may safely be made is the appendix This organ is apt to be much contorted and is often bent acutely upon itself The most difficult adhesions are met with when the appendix is adherent to the floor of the pelvis and is pos sibly in communication with the rectum A good electric light a full retraction of the margins of the wound a very free inci sion and the Trendelenburg position are necessary in these very troublesome cases

In detaching an adherent appendix a small abscess cavity may be discovered It may possibly communicate with the bowel It should be well sponged out and a small drainage tube will be needed

Treatment of the pedicle.— As the appendix is being isolated care should be taken to demonstrate its pedicle The pedicle repre ents the meso appendix or at least the source of the blood supply of the appendix There may be no meso appendix the appendix may derive its blood supply direct from cæcal arteries or direct from adhesions we have found it supplied apparently wholly from adherent omentum Some times the appendix is found to be fibrous and shrunken and in such case its blood supply may be very small

In an uncomplicated case the appendix and its mesentery are readily brought out of the wound and the rest of the operation may be described as it would apply to such a case The meso appendix is spread out When the organ is in volved in the cæcal fossæ this may not be readily done until the folds of peritoneum which hide the meso appendix are divided These folds do not represent adhesions Close to its base a gap will always be noticed between the blood vessels going to the appendix The meso appendix is perforated at this gap and a catgut ligature is passed through by means of an aneury m needle This liga ture will suffice to secure the meso appendix when it is small when it is wide the membrane and its vessels should be secured by two ligatures The meso appendix is now divided well on the distal side of its ligature or ligatures Alternatively the meso appendix may be secured by pressure forceps and

CHAPTER VI

OPERATIONS ON THE STOMACH

The following operations upon the stomach will be described

1. Gastrostomy
2. Gastrotomy
3. Operation for hypertrophic stenosis in infants
4. Gastro jejunostomy
5. Resection of the stomach for ulcer or neoplasm
6. Vagotomy

I Gastrostomy

This operation consists in establishing an artificial opening (*stoma*) in the stomach through the parietes with the purpose that the patient may be fed through the new 'mouth"

Gastrostomy is rarely carried out for obstruction of the gullet due to malignant disease except as a temporary measure to nourish a patient prior to excision of the tumour As a palliative treatment it has the grave disadvantage that the patient cannot swallow his saliva The operation is sometimes performed to allow of serial dilatation of a simple œsophageal stricture

Preparation of the patient —If the patient is no longer able to swallow his strength should be supported by giving glucose salines per rectum There is no need to adopt any special means of distending the stomach The body should be well covered up with blankets and the limbs surrounded by hot water bottles

Local anæsthesia is the anæsthetic of choice although light general anæsthesia can also be used The quicker the operation can be carried out within reason the better

them the edges of the wound are kept in perfect line and the parietes are withdrawn from the subjacent viscera The pressure forceps which still holds the cut edges of the peritoneum is r moved by cutting away the little tag of (damaged) peritoneum which it grips between its blades The peritoneum is united by a continuous catgut suture and the separated internal oblique and transversalis muscles are approximated by one or two interrupted catgut sutures The external oblique aponeurosis is similarly united and the skin approximated by silkworm gut sutures

Modifications —The chief modifications of the operation relate to the incision employed The incision through the rectus shea h has already been described Another method is to place the incision (a nearly horizontal one) half outside and half over the outer border of the rectus muscle the sheath of which is opened and the muscle retracted With care as to the deep epigastric vessel I have found this an excellent incision

In conclusion it may be noted that appendicectomy though a simple enough operation in most cases now and then presents extreme difficulty and may demand a long incision through the abdominal walls The paramedian incision best allows of extension, especially for exploration upwards In searching for the appendix Murphy s rule —to find first the lower edge of the ileo cæcal junction and to look in this angle—is invaluable

Retrograde Appendicectomy.—In certain cases in which the tip of the appendix is difficult to deliver becau e it is buried deeply and adherent retrocæcally in the pelvis or elsewhere this procedure may help The appendix is defined at its base and is there separated from the cæcum Two hæmostats are passed each with one blade between the appendix and the cæcum and are clamped closely adjacent on the appendix base The appendix is divided between the hæmostats The stump of the appendix is treated as above The mesentery of the appendix is clamped and divided from appendix base to the free edge of the mesentery Traction exerted gently on the appendix puts the mesentery on stretch

more certain the relations of the viscus to adjacent structures and especially to the liver should be made out.

The colon has been mistaken for the stomach and has been opened under the influence of that error The stomach is usually contracted and lies high up, under cover of the left

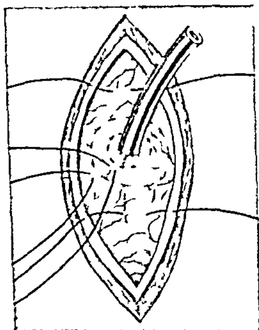


Fig 164 —Gastrostomy Introduction of the purse string sutures

lobe of the liver In such case the omentum or the transverse colon commonly presents By means of a gauze sponge held in long pressure forceps the colon may be thrust downwards into the abdomen and the stomach thus brought into view or the surgeon may draw the colon downwards with his fingers The omentum is more conveniently pushed away by means of the sponge to the surface of which it readily attaches itself

In any case of doubt the surgeon should follow the under surface of the liver with his finger as far as the portal fissure

Special instruments required.—A sharp tenotome to open the stomach and a rubber tube or catheter of about No 12 size

The Kader Senn operation—1 *The parietal incision*—The surgeon should endeavour to mark out the lower edge of the liver by percussion and palpation The normal position of this edge is about two fingers breadth below the ensiform cartilage The liver however in the operation area may be found as high up as the level of the xiphoid cartilage or as low down as the level of the ninth costal cartilage In cases of stricture of the gullet the organ is usually a little lower than normal, owing to the empty condition of the stomach and intestines

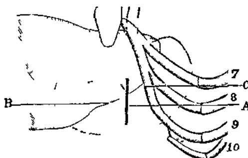


Fig 163 —Gastrostomy

A Incision B margin of the liver C margin of the costal cartilages 7 8 9 and 10 seventh to tenth costal cartilages

The incision from 2 to 3 inches long is made over the left rectus muscle about 2 or 3 inches from the mid line (Fig 163) The sheath of the rectus being opened the muscle is split its inner part retracted slightly and the posterior layer of sheath divided to the same extent then the peritoneum The wasting of the patient may cause the abdominal wall to be very thin

2 *Exposure of the stomach*—Retractors are introduced into the wound and search is made for the stomach The liver will come into view and below the margin of that organ the stomach may at once be detected It is recognized by the smoothness and absolute opacity of its surface by its white or pinkish white colour and by the thickness and stiffness of its wall as demonstrated by pinching up a fold between the thumb and finger To make the identification

The exact position and size of any foreign body must be ascertained beforehand by radiography

The incision should be at first about 2½ inches in length It may be enlarged subsequently as required

The peritoneum is divided and the stomach sought for If the contained foreign body be sharp pointed the manipulation of the stomach must be conducted with great care

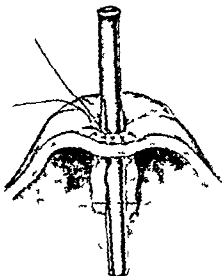


Fig 165 —Gastrostomy the rubber gastrostomy tube *in situ*

When the surgeon has determined upon the spot at which the opening into the stomach is to be made two silkworm gut sutures may be passed through the serous and muscular coats of the viscus one on either side of the area selected for the incision These sutures are allowed to form long loops, by means of which the stomach can be drawn forwards and held in place

The stomach wall should be gently drawn well into the parietal wound and before the opening is made the space between the viscus and the margins of the parietal incision must be plugged with sterilized gauze

Thence he is conducted to the stomach by the gastro hepatic omentum

The stomach should be drawn to the wound and the spot at which to open it must be determined

This spot should be as near to the cardia as possible half way between the greater and lesser curvatures, and at a part free from large veins

A small opening is made at the site selected of just sufficient size to admit a No 12 rubber catheter This is inserted into the stomach for about 2 inches and fixed in position by a catgut stitch which pierces it and all the coats of the stomach (Fig 164)

A purse string suture is inserted picking up the sero-muscular coats of the stomach only, and placed half an inch away from the tube The tube is tucked in by an assistant as the purse string is drawn tight Two or more similar sutures are inserted, with the result that the tube passes through a cone of stomach wall resembling an ink bottle (Fig 165) The cone is fixed to the parietal peritoneum and the abdomen is closed A feed is given through the tube while the patient is still on the table

The tube becomes loose after 7 to 10 days when it must be replaced by another one and fitted with a spigot or clip as otherwise the track rapidly closes

This is an operation which can be performed with celerity on a small contracted stomach and is less complicated than the operation devised by Witzel The latter makes a lateral tunnel in the stomach wall

II Gastrotomy

This term is applied to the operation of opening the stomach for the purpose of removing a foreign body or for exploration. Gastrotomy has been employed in dilating the pylorus in infants for 'hypertrophic stenosis'

There is no need to attempt to bring about an artificial distension of the stomach before the operation.

The operation —The parietal incision is a vertical one paramedian through the left rectus and its sheath

The exact position and size of any foreign body must be ascertained beforehand by radiography

The incision should be at first about 2½ inches in length It may be enlarged subsequently as required

The peritoneum is divided and the stomach sought for If the contained foreign body be sharp pointed, the manipulation of the stomach must be conducted with great care

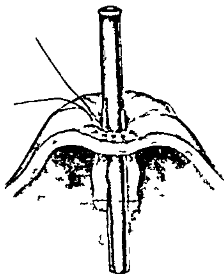


Fig 165 —Gastrostomy the rubber gastrostomy tube *in situ*

When the surgeon has determined upon the spot at which the opening into the stomach is to be made two silkworm gut sutures may be passed through the serous and muscular coats of the viscus one on either side of the area selected for the incision These sutures are allowed to form long loops by means of which the stomach can be drawn forwards and held in place

The stomach wall should be gently drawn well into the parietal wound and *before the opening is made* the space between the viscus and the margins of the parietal incision must be plugged with sterilized gauze

The incision into the stomach should be transverse to the long axis of the viscus—i e in the line of the blood vessels

As soon as the organ has been opened the forefinger is introduced and the position of the foreign body made out It should be so manipulated as to place it in the position best suited for ready removal

Forceps will probably be required to effect the extraction Care must be taken not to damage the wall of the stomach by rough manipulation or by attempts to drag the foreign body through too small an incision

The next step is the closure of the wound by suture The divided mucous membrane is first of all brought together by means of a continuous catgut suture This is best introduced by a small fully curved needle held in a needle holder The suture is knotted at one end drawn taut as it goes and knotted again at the other end The laxity of the gastric mucous membrane renders the application of this suture an easy matter

The outer part of the gastric wound is closed by many points of Lembert's sutures These are of fine catgut and include both the serous and muscular coats The details of the suture have been dealt with in an earlier chapter (p 328)

The parts having been well cleansed the gauze is removed and also the guiding loops of silkworm gut from the stomach wall

The parietal incision is closed in the usual way

III PYLOROPLASTY

It will be convenient to describe here briefly the best methods of operating for pyloric narrowing or stricture due to muscular hypertrophy in infants (Fig 166)

Gastro jejunostomy was tried at first for these infantile cases but it is too long an operation and the mortality has been heavy An entirely different procedure is that known as **Rammstedt's operation,** which is extensively practised Before operation the stomach is washed out and a little fluid left

in The child is usually held on a splint of "crucifix" shape General or local anæsthesia may be employed In the latter case the epigastric region is infiltrated with 2 per cent novocain in adrenalin 1–20 000 a wheal being raised up to and over the ensiform process from just below the transpyloric plane and also one on each side at the costal margin about 5 c c of solution suffices A midline incision 2 inches long is made starting at the ensiform process the peritoneum is opened and the liver is seen guarding the wound the finger is insinuated under its edge and the stomach drawn up, the hyper

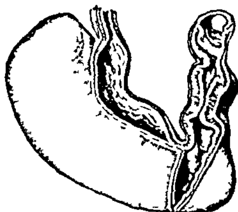


Fig 166 —Congenital hypertrophic stenosis *of the pylorus*

Note the great hypertrophy of the pyloric musculature

trophied pylorus being easily felt, it is grasped between the finger and thumb of the left hand and with a scalpel an incision is made in its long axis This incision cuts the hypertrophied sphincter allowing the mucous membrane of the pyloric canal to bulge through and the remaining fibres are scraped through with a blunt director (Fig 167) The stomach is gently squeezed both to prove the ease of passage into the duodenum and also to detect any breach of the duodenal mucosa—a not uncommon accident The stomach is returned to the abdomen the liver slipping back into position and the wound is closed in layers The operation can be done gently and comfortably in five or six minutes The after feeding is very important

2 Cicatricial stenosis of the pylorus is best treated by posterior gastro jejunostomy A plastic operation on the scarred tissues is rarely satisfactory owing to recurrence

IV GASTRO JEJUNOSTOMY (Fig 168)

This operation consists in establishing a permanent communication between the stomach and the first coil of the jejunum just below the end of the duodenum Its main uses are —

1 When stenosis has occurred at or near the pylorus due to scarring of a duodenal ulcer Its use should be confined to the elderly whose ulcer activity has burned out and whose gastric acidity is low In younger patients whose gastric acidity is high it may be used as a temporary measure to allay the vomiting of pyloric obstruction but gastrectomy is a better procedure and can be carried out later

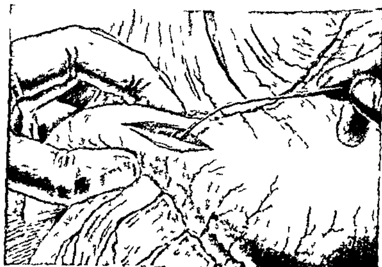
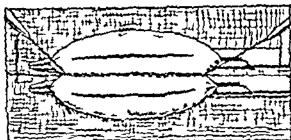
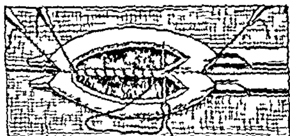
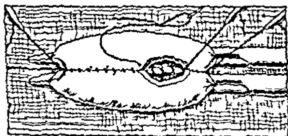


Fig 167 —Rammstedt s operation







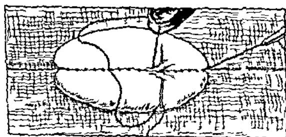


Fig 168.—Stages of gastro jejunostomy

2 To allow a recurrent duodenal or gastric ulcer to heal in an ill patient with a view to resection later
3 When hourglass contraction has occurred from cicatrization of a gastric ulcer
4 As a palliative measure to overcome obstruction from an inoperable pyloric growth
5 Combined with vagotomy as an alternative treatment to partial gastrectomy for duodenal ulcer in a young patient thus conserving the stomach as a receptacle for food
6 In cases of duodenal atresia in infants
7 In certain cases of pancreatic neoplasm obstructing both the common bile duct and duodenum

It must be pointed out here that gastro jejunostomy does not drain the stomach well

The object of the gastro jejunostomy under these conditions is twofold—to relieve obstruction to the stomach by emptying its contents and by giving rest to the organ to encourage healing of the ulcer

In all cases of ga tro jejunostomy the first coil of small intestine below the fixed duodenum must be attached to the stomach Thus whatever method be employed the surgeon must first find the termination of the duodenum which is anatomically fixed in front of the aorta behind the transverse colon The demonstration of the commencement of the jejunum is best effected by drawing the transverse colon upwards and by then passing the fingers along the under surface of the transverse mesocolon until the vertebral column is reached Just to the left of the spine the terminal part of the duodenum will be discovered This will lead to the jejunum and traction upon the coil seized will demonstrate that it represents the very commencement of the jejunum

It is important to favour as far as is possible the contents of the stomach passing into the descending limb of the jejunal loop For this reason the intestine should be so sutured that its axis may correspond with that of the

stomach—i e both running from left to right Further the direction of the loop secured should be obliquely downwards, and the opening in the stomach made low down (towards the great curvature) and near the pyloric end if possible

The loop of jejunum may be fixed to the posterior surface of the stomach through an opening made in the transverse mesocolon (posterior gastro jejunostomy) or it may be brought in front of the transverse colon and fixed to the anterior wall of the stomach (anterior gastro jejunostomy) The former is the operation of choice the anterior method being rarely used, and only in cases unsuitable for the other

Instruments required.—These are of a simple kind, and no special ones are needed with the exception of two straight clamps for the stomach and intestine The operation may be done without clamps, but their use renders it easier and quicker in performance Straight and curved eyeless needles charged with fine catgut, should be prepared A fine scalpel dissecting and pressure forceps and straight fine pointed scissors are essential

1 Posterior gastro jejunostomy by suturing.—In some cases and especially if the stomach has been dilated, it should be washed out through a soft rubber œsophageal tube just before the operation A glass funnel is attached to the tube and warm water poured through the funnel lowering the latter below the level of the patient's head (he is of course, recumbent) to reverse the current The washing out is continued until the contents come back quite clear and care should be taken to empty the stomach so far as practicable

The patient must be wrapped up warmly and only the necessary part of the abdomen should be exposed The temperature of the theatre as in all abdominal operations should be a suitable one as near 75° F as can be obtained A pillow or sand bag should be placed behind the upper part of the abdomen

The incision is a right or left paramedian extending from just below the xiphoid process to the umbilicus

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The incision is a right or left paramedian extending from just below the xiphoid process to the umbilicus

When the peritoneal cavity has been opened (any bleeding vessels being ligatured) the surgeon examines the stomach and draws both its *pyloric portion* and the *colon out of the wound*

The transverse colon and the great omentum are turned upwards and the under layer of the mesocolon is exposed An aperture is made in the latter avoiding the branches of the *middle colic* and vein Through this aperture the posterior

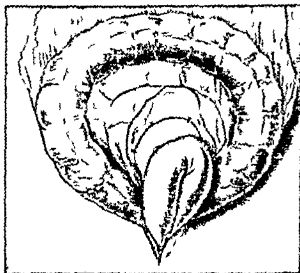


Fig 169 —Completion of gastro jejunostomy the aperture in the mesocolon sutured to the stomach

The relation of the opening in the mesocolon to the vessel loops of the latter is well shown

wall of the stomach is drawn a sufficient area being exposed in which to make the anastomosis The area of stomach selected should be near both the pyloric end and the greater curvature The projecting portion of stomach wall is now grasped by a clamp The end of the duodenum and commencement of the jejunum is next found in the manner

already described (p 372), and the first few inches of the jejunum is emptied of its contents by the fingers and seized by the second clamp The transverse colon is pushed back within the abdomen so far as is possible and the two clamps are placed parallel and close to each other (transversely to the wound in the parietes) so as to bring the stomach and intestinal wall in close contact Large gauze pads or warm, flat sponges are now packed beneath the clamps all round the projecting parts of stomach and intestine which are thus isolated

The method of suturing employed in the above operation is as follows The adjacent surfaces of the stomach and jejunum are approximated by a continuous catgut suture for a distance of 2½ to 3 inches An incision is made into each viscus parallel with this suture line and about an eighth of an inch removed from it but it does not extend for quite the full length of the first suture This is most easily performed with a pair of fine pointed straight scissors Redundant mucosa may be cut away but this is not necessary

The second row of sutures brings the edges of the opening into stomach and jejunum respectively into close contact all round here also the continuous method is the best and most rapid This suture must be hæmostatic and it is wise to lock every third stitch Before completing this line it is advisable to slacken off the clamps and *look* to see if any bleeding occurs Any bleeding vessel is undersewn with a separate stitch and tied The third row, which is practically a continuous Lembert suture traverses only the outer coats of both viscera Two or three additional Lembert s sutures at either end may be required to take off the strain on the others and to prevent sharp kinking of the intestine The clamps are removed as soon as the surgeon is satisfied with the suturing—i e when the aperture is made water tight

One final and important step remains to secure the edge of the opening in the mesocolon by three or four separate sutures to either the stomach or intestine wall around their anastomosis (Fig 169) Unless this is done, small intestine may subsequently work up in the gap and produce a hernia

A clamp on the stomach undoubtedly facilitates the procedure in most cases on the other hand if none is used the surgeon is able to explore the interior of the stomach with his



Fig 170 —Anterior gastro jejunostomy

A loop of the jejunum is drawn in front of the great omentum and transverse colon and is fixed to the anterior wall of the stomach The opening between the two has been made and the final continuous suture is shown drawing the outer coats of the two viscera together

finger This however is open to objection on the ground that it introduces some risk of infection of the wound

It is important to control all bleeding vessels in the wall of either stomach or intestine by ligature

All the gauze packing or sponges are now removed the sides of the abdominal wound are held forward so that the stomach and the jejunum slip back, and the parietal wound is closed in the usual manner

It is well to emphasize the selection of the proper part of both stomach and jejunum in which to place the anastomosis As regards the stomach this must be low down, near the greater curvature and as near the pylorus as convenient The opening in the jejunum must be made so as to leave no loop between it and the part fixed to the spine by the suspensory ligament

2 **Anterior gastro-jejunostomy by suturing.**—The indications for this operation are few and it should only be performed when a posterior gastro jejunostomy cannot be performed e g adhesions non mobile stomach or extensive carcinoma involving the posterior wall of the stomach The abdomen is opened in the middle line above the umbilicus and the stomach region is explored The great omentum is pushed to the left, and the first coil of jejunum is identified in the manner described and is then drawn forwards in front of the transverse colon so that it can be brought in contact with the stomach The anterior wall of the latter is brought out of the wound as well as the piece of jejunum and both are packed round with sponges or gauze compresses Care is taken that there is no strain put upon the jejunum when it is drawn into place If the loop of jejunum be too short it acts as a strap across the transverse colon and drags upon the stomach The selected coil of jejunum is held by an assistant whose fingers act as compressors The stomach also is drawn into the parietal wound and the point at which it is to be opened decided upon This should as a rule be near both pylorus and greater curvature but as anterior gastro jejunostomy is usually performed in cases of extensive carcinoma the exact site will depend upon the position of the latter (Fig 170)

The remaining steps of the operation hardly differ from

those of posterior gastro jejunostomy the method of suturing being exactly the same There is a greater tendency for post-operative vicious-circle vomiting to follow the anterior operation This may be avoided by performing an entero anastomosis between the efferent and the afferent loops of jejunum

Comments on gastro jejunostomy.—At first the anterior method was alone used but posterior gastro jejunostomy has almost entirely replaced it The reasons given for the preference of the posterior method are—(1) the opening is lower down in the stomach (2) the commencement of the jejunum is opened instead of a part of the gut several inches from this point hence regurgitation is less common and *the stomach evacuates itself more readily* (3) *there can be* no interference with the transverse colon by the jejunal loop and no risk, therefore of intestinal obstruction

Note the special importance of (2) in a satisfactory anastomosis between stomach and jejunum there must be no *loop left between the aperture and the fixed end of the duodenum* In certain cases especially those of duodenal ulcer it is desirable to close the natural pyloric opening for a time so that all the food shall pass through the new communication and so give the ulcer rest This can be effected easily by passing a catgut ligature round the pylorus and tying the loop securely After a time the ligature is absorbed and the pyloric aperture restored

In cases of perforated gastric or duodenal ulcer after the surgeon has dealt with the perforation and its peritoneal *results he may decide to complete the operation by doing a* posterior gastro jejunostomy There is a difference of opinion as to the wisdom of this course but the vast majority of surgeons in this country are against it unless chronic ulceration or previous perforation has caused duodenal stenosis *In these circumstances the feasibility of partial gastrectomy* should be entertained

Finally a warning is required against performing gastro jejunostomy in unsuitable cases where no clear indication for it is present Symptoms of gastric ulcer may be simulated

by appendicitis and functional disease, in such cases gastro jejunostomy will only do harm

V RESECTION OF STOMACH

Gastric resection is performed in cases of

i Chronic Gastric or Duodenal Ulceration

ii Neoplasm of the stomach

Subtotal Gastrectomy, of the Ante Colic Polya type will be described in detail as it is performed in cases of Peptic ulceration Various modifications in general use will then be mentioned, and also modifications practised when the operation is performed in cases of gastric carcinoma

Subtotal Gastrectomy —The abdomen is opened by a right or left superior paramedian incision or by a transverse incision

The great omentum and transverse colon are drawn through the wound (after adequate exploration of the abdomen has confirmed the diagnosis) The gastrocolic ligament is put on the stretch and an avascular area is chosen well to the left of the greater curvature This part of the omentum is incised in an avascular area and a wide opening is made into the lesser sac

Any adhesions in the lesser sac between the superior leaf of the mesocolon and the posterior wall of the stomach or between a gastric ulcer and the mesocolon are separated by blunt or sharp dissection The middle colic vessels and possibly branches of the right colic are freed from the posterior aspect of the stomach if they are adherent

The vessels which arise from the inferior aspect of the right gastro epiploic artery are isolated picked up with hæmostats divided and tied off with No 4 silk or No 2 catgut one by one until the lower aspect of the pylorus is reached The right gastro epiploic vessels are now divided between ligatures as they come into view beneath the pyloric antrum

The right gastric artery is now identified on the upper aspect of the pylorus and it is underrun by two silk ligatures and divided between them

The pylorus and the first part of the duodenum can now be drawn forwards from the pancreas and the numerous vascular bands on the superior posterior and inferior aspects of the duodenum can be underrun and ligatured or clamped with hæmostats and divided The bands found posteriorly are best isolated with a dissector or long non toothed forceps before ligaturing and dividing them If a posterior wall duodenal ulcer is firmly adherent to the pancreas care must be taken the pancreas may be injured the duodenum opened, the common bile duct damaged or much hæmorrhage produced If there is deep penetration into the pancreas the duodenum must be dissected free The ulcer base is left *in situ* and is destroyed carefully by electric cautery

In cases of duodenal ulceration the duodenum should be freed for ½ in beyond the ulcerated area so that sufficient tissue is left to allow closure of the duodenal stump though on occasion it may be necessary to close the duodenum proximal to an ulcer and leave the ulcer behind Such cases heal perfectly satisfactorily provided the whole of the pyloric antrum is removed

Two Payr s crushing clamps are now placed acros a convenient area of the first part of the duodenum distal to to the ulcer and duodenum is divided between them The operative field should be packed off before the bowel is divided

The clamp on the gastric side of the division is covered with gauze or jaconet and is drawn over to the left The clamp on the duodenal stump is rotated laterally to expose the posterior surface of the duodenum The duodenum is sutured over the clamp with a continuous right angled suture from upper to lower margins the suture is drawn tight as the clamp is released and the duodenal wall is inverted The suture is now carried back to the starting point as a continuous Lembert stitch and tied A few carefully placed interrupted catgut sutures are inserted and a convenient piece of omentum drawn down and sutured over the duodenal stump completes the closure (NOTE —The duodenal stump may also be closed by two or three purse string sutures)

A warm pack is placed over the newly sutured stump This must be remembered and removed at the end of operation (Fig 171)

The stomach is now picked up held well over to the patient's right side and the left margin of the wound is retracted The left part of the great omentum with the gastro-epiploic vessels are brought into view All remaining

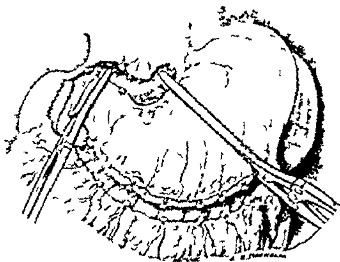


Fig 171.—Partial gastrectomy showing the method of application of the clamps and the closure of the duodenum

blood vessels along the greater curvature up to the level of the main splenic pedicle are isolated and divided between hæmostats one after another The lower two thirds of the gastro splenic omentum should be divided Some surgeons do not ligate the main gastro epiploic vessels but tie the branches of the arcades along the greater curvature separately This maintains the blood supply to the great omentum which otherwise is converted into a shrunken fibrous mass This procedure however takes time and is not done in the



the stomach, high up Moynihan's clamps may now be applied to the vessels which are then divided Silk ligatures are applied and the clamps released but before ligature of the vessels on the lesser curvature, these are stripped downwards for a short distance

The stomach is now freely mobile and the anastomosis to jejunum may be proceeded with The anastomosis is most conveniently made with the use of gastro-enterostomy clamps The stomach is drawn down firmly, and the upper clamp is placed across the stomach from greater to lesser curvature at the highest level of clearance of the curvatures i e from just below the level of the main splenic pedicle to a point just below the cardia The stomach is now turned up over the left costal margin and the first loop of jejunum identified as described on p 372 A suitable length of jejunum to correspond to the stump of the stomach is placed in the lower gastro-enterostomy clamp a strip of gauze is placed across the wound between the two clamps and the clamps are interlocked over it

The operative field is carefully packed off

The adjacent walls of stomach and jejunum are united by a continuous seromuscular suture of catgut on an atraumatic needle The stomach and jejunum are opened along the whole length of the line of junction and ⅛ in away from it A hæmostatic through and through catgut suture on an atraumatic needle is used to unite the posterior wall of the stump of the stomach to the adjacent wall of the jejunum The anterior wall of the stomach is now divided leaving a little more tissue distal to the clamp than when dividing the posterior wall The rest of the anastomosis is completed in exactly the same fashion as described for gastro jejunostomy, and illustrated in Fig 168

The clamps are removed the gauze strip behind the anastomosis is removed and the latter is allowed to return to the abdomen (Fig 172)

The abdominal cavity is inspected to make sure that hæmostasis is complete the pack over the duodenal stump is removed, and the abdomen is then closed in layers

Modifications of operation in cases with Peptic Ulcer

(1) A post colic anastomosis may be made by pulling jejunum up through an opening in transverse mesocolon before commencing the anastomosis

(2) The part of the gastric stump adjacent to the lesser curvature may be closed before junction to the jejunum so that only the part of gastric stump adjacent to the greater curvature forms the stoma (Hofmeister)

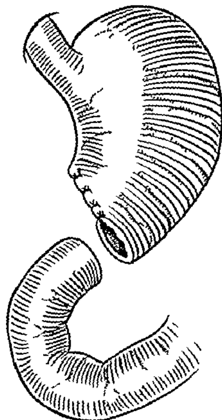


Fig 173 —Diagram showing Billroth I operation

(3) The jejunum may be anastomosed to the gastric stump both in the ante and post colic operations so that the anastomosis is either iso or retro peristaltic

(4) The stomach remnant may be directly anastomosed to the duodenal stump (Billroth I) thus preserving the form of the organ It is especially suitable for lesser curve gastric ulcers

Modifications when the resection is performed for carcinoma of the Stomach

The purpose of operation in these cases is to excise the

growth with a wide margin of healthy tissue above and below the diseased area This would also include (Maingot) (i) the removal of at least two thirds of the first portion of the

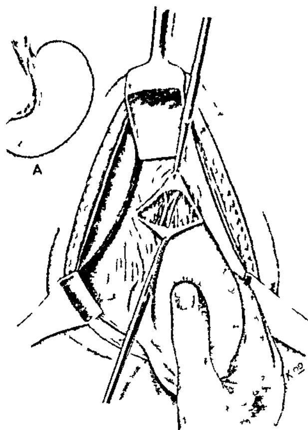


Fig 174 —Vagotomy exposure of the left Vagus nerve

duodenum (ii) the removal of the whole or nine tenths of the lesser curvature of the stomach (iii) the removal of at least six sevenths of the greater curvature of the stomach (iv) the

Modifications of operation in cases with Peptic Ulcer

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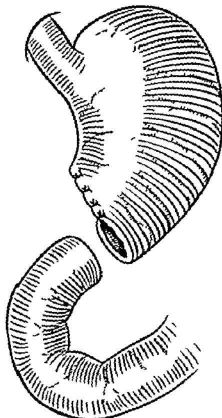


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gastro hepatic omentum, and the superior leaf of the meso colon

VI VAGOTOMY

A transthoracic or a transabdominal approach may be used for the performance of resection of the vagus nerves as they approach the cardia The former approach is preferred by surgeons accustomed to opening the chest the latter approach is used by the great majority of surgeons and is in many ways to be preferred The great advantage is that the diagnosis can be confirmed when the abdominal route is used

Gastric Vagotomy by Transabdominal approach —The abdomen is opened by a high right or left paramedian incision The left coronary ligament of the liver is identified and divided and the left lobe of the liver is retracted to the right The upper part of the stomach and the lower end of the œsophagus are now in view, and a small incision is made in the peritoneum over the anterior aspect of the œsophageal hiatus Through this aperture the surgeon's index finger is introduced and by gentle manipulation the lower part of the œsophagus is separated from the surrounding areolar tissue and can be pulled downwards into the abdomen Further procedures are rendered more easy if a broad tape is passed behind the lower end of the œsophagus and is used as a retractor

The left anterior vagus nerve is usually seen extending along the front of the œsophagus towards the lesser curvature of the stomach The right or posterior nerve is felt as a firm cord behind the œsophagus usually close to its right border, it is approached by rotating the lower end of the œsophagus Each nerve is in turn separated from the wall of the œsophagus with the numerous branches The vagi are pulled downwards and divided about 5 centimetres above the cardia and the parts between the point of division and the cardia are excised (Figs 174 and 175)

The vagotomy is now complete and the opening in the peritoneum at the œsophageal hiatus can be closed with two or three interrupted sutures The left lobe of the liver is allowed to fall back into place and the abdomen is closed

removal of all the regional lymph glands, such as the supra pyloric the retro and infra pyloric the glands along the lesser curvature—lower coronary and upper coronary—the paracardial glands and those along the greater curvature

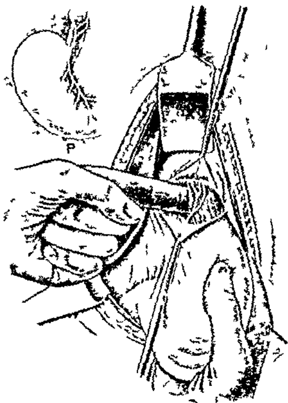


Fig 175.—Vagotomy exposure of the right Vagus nerve

—the gastro epiploic (v) the removal of the great omentum which is detached from the colon the major portion of the

CHAPTER VII

OPERATIONS ON THE GALL BLADDER THE MAIN BILE DUCTS AND SPLENECTOMY

I Cholecystostomy

By this operation is meant the making of an incision into and drainage of the gall bladder through a wound in the abdominal parietes It is employed for the treatment of empyema of the gall bladder and in a few other conditions but surgical opinion is now strongly in favour of excision of the gall bladder (cholecystectomy) in every case of gall stones in the bladder or cystic duct if possible The question is discussed on p 396

Special instruments required—The rubber tube used for drainage of the gall bladder should be a long one long enough to reach to the side of the patient s bed The end to be *inserted may be turned back and on itself to* prevent it from slipping out though this is not absolutely necessary Various forms of flexible scoops and of forceps for grasping the stones (including Lawson Tait s ingenious pattern) may be found useful Trocar and cannula

Operation.—The general management of the operation the preparation of the patient the position of the surgeon and his assistants conform to the lines already laid down in dealing with abdominal section Great assistance will be obtained in exposing the gall bladder region by placing behind the patient s loins a large sand bag or firm pillow so as to lift up and render convex the epigastrium Most operating tables are now provided with a movable bridge which is more convenient than a pillow

Vagotomy alone for duodenal ulcer is too fraught with complications to be generally used It is used by many surgeons together with gastroenterostomy or a small gastrectomy removing only the pyloric antrum and duodenal cuff as a treatment for duodenal ulcer in young people The operation avoids the great loss of weight which occurs after subtotal gastrectomy The operation is also of value in the treatment of stomal ulceration following partial gastrectomy or gastro jejunostomy

To prove that all the vagal fibres have been divided an insulin test meal is usually given before and about ten days after operation After complete vagotomy the profound pouring out of acid induced by injecting 20 units of insulin intravenously is abolished

2 The same as above with an extension outwards from its midpoint
3 The oblique incision of Kocher parallel to and 1 inch below the costal margin
4 The transverse incision of Rutherford Morison, which is very useful in cases of suppuration

The peritoneum is opened and the area of the operation is explored with the forefinger The wound is enlarged as required. Intestine may protrude and hamper the surgeon's movements or the omentum may be found in the way or an enlarged liver may overshadow the operation region It is not uncommon for the gall bladder to be completely hidden at first and the operator must then lay bare not only it but the cystic duct as well Recent adhesions should be gently detached with the finger, firm omental adhesions may need ligature before division

The gall bladder and the cystic and common ducts should then be palpated (if possible the left index finger is passed through the foramen of Winslow) in order to ascertain the exact position of any calculi

If the gall bladder be found to be of great size or very tense from over distension it should be carefully aspirated The site of the needle puncture is protected by sponges which are wedged in position As the gall bladder is emptied its wall is gradually and gently brought into the parietal wound This is not always an easy matter and as the wall is often thin or inflamed it must needs be handled with great gentleness

Care must be taken that no fluid escapes into the peritoneal cavity If the gall bladder be but slightly distended its wall may be brought to the surface without previous aspiration In some cases the enlarged gall bladder can be brought outside the wound

The gall bladder is best held and drawn forwards by means of pressure forceps The amount of traction exercised must be very judiciously regulated The wall of the gall bladder is then opened by an incision made between the retaining forceps all bleeding points are dealt with and the forceps are readjusted so that the gall bladder may be drawn well forwards

The following are the incisions most commonly used in gall bladder surgery (Fig 176) —

1 A paramedian incision half an inch to the right of the midline with displacement outwards of the rectus

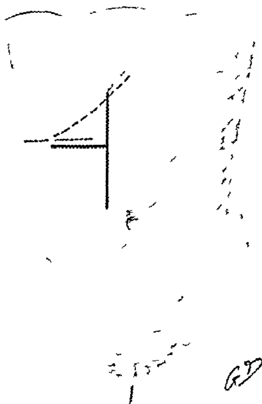


Fig 176 —Incisions for exposure of liver or bile ducts

The vertical incision is commonly employed the extension upwards and inwards (Mayo Robson) greatly helps the exposure A cross cut through the right rectus may be necessary in difficult operations for reconstruction of the bile ducts etc The oblique incision through the rectus is that introduced by Kocher and the nearly transverse incision (dotted transverse line) is recommended by Rutherford Morison

by catgut sutures that it closely embraces the end of the long rubber tube The opening may be made valvular by a similar proceeding to that figured and described in the section on Gastrostomy (p 363) It is well to secure the tube, which need only project a short distance into the gall bladder by a cat gut stitch which traverses the wall of both tube and bladder

Formerly the gall bladder was always anchored to the abdominal wall usually at the upper end of the wound by an extra suture or two If this is done the peritoneum and fascia alone should be sewn to the gall bladder but as a rule it is unnecessary By the time the tube comes away omental and other adhesions will prevent any leakage When the tube is fixed in place the rest of the abdominal wound is carefully closed by sutures in the usual way

It is a good plan to have the tube of sufficient length to reach into a bottle at the patient s side thus the wound can be kept quite dry until the tube can be removed—i e in ten days to three weeks time

II Cholecystectomy

The operation.—The abdomen is opened by a vertical incision through the outer part of the rectus muscle, with, if required an extension upwards and inwards at the upper end downwards and outwards at the lower end of this vertical cut The gall bladder is carefully separated from surrounding adhesions until both it and the cystic duct are isolated The under surface of the liver is made to project forwards both by the presence of the sand bag behind the patient s back and by the assistant who draws forwards and tilts the liver edge upwards (Fig 177) Gauze pads are inserted as in chole cystostomy The peritoneum covering the cystic duct is now incised *transversely and carefully reflected* The surgeon works round the cystic duct with a blunt dissector in the same way as he would prepare an artery for ligature A blunt aneurysm needle may be used to encircle the duct which is very securely tied with catgut near to its junction with the hepatic duct A cholecystectomy clamp is fixed on the duct nearer the gall bladder and the duct is divided

and held in position between the lips of the parietal wound By means of properly applied sponges or large gauze pads the escape of fluid into the peritoneal cavity is prevented

The finger introduced through the opening feels for the stones notes their position and ascertains the best means for removing them Loose stones may be removed with the finger or by means of scoops or forceps of suitable size and pattern Long and slender scoops—aided by a finger outside the gall bladder—are more useful than forceps

In dislodging stones Tait s special forceps are occasionally of service and their movements within the bladder may be guided by the finger introduced into the abdomen Some times the stone may be prised upwards by means of the finger so introduced

If the calculus cannot be dislodged then it may some times be very slowly and cautiously chipped into fragments by means of forceps the action of which is controlled by the finger outside the gall bladder In some cases the impacted stone has been broken up by means of forceps the blades of which are padded with indiarubber tubing applied to the stone outside and therefore through the walls of the neck of the gall bladder or by pressure between finger and thumb Both these methods of breaking up a stone are attended with considerable risk unless the gall bladder be removed at the same time Moreover few things are more difficult than the extraction of the broken fragments from the cystic duct They are likely to work down to the pancreatic end of the common duct and collect there

As a rule it is unsatisfactory to leave an impacted calculus in either of the ducts it is better to remove it by direct incision We advise however that cholecystectomy should be done in this case if possible The operator should do his utmost to convince himself that all obstacles in the way of the bile flow are removed before completing the operation

The treatment of such stones as are impacted so low down in the duct as not to be reached from the gall bladder is dealt with under Choledochotomy (p 397)

The opening in the gall bladder should now be so narrowed

bladder by a continuous catgut suture The object of this is to avoid leaving a raw surface of liver to which the stomach, etc, will become adherent It is not however, always possible to reflect the peritoneum for suture as described The sand

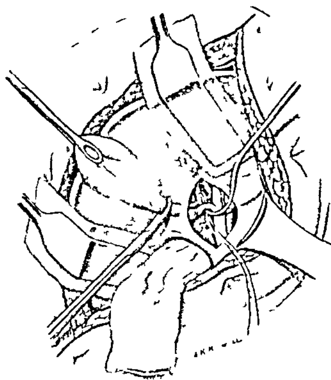


Fig 178 —Cholecystectomy

A piece of gauze has been placed in the foramen of Winslow and the cystic duct tied

bag is now removed from under the back and all sponges from the abdomen A soft rubber drainage tube is inserted well under the liver and brought out through a separate stab wound the rest of the abdominal wound being firmly closed layer by layer Many operators leave a plug

between the clamp and the ligature The cystic artery and vein are also cleared and divided between two ligatures These vessels are usually found with ease as they lie on the left of and close to the cystic duct It should be noted that a fair sized branch of the hepatic artery is often met with to the right of the duct this occurs in over 30 per cent of persons (Brewer) If present this artery also should be secured between two ligatures (Fig 178)



Fig 177 —Method of rotating the liver when removing the gall bladder

Many operators do not use the aneurysm needle in the above procedure but pass two clamps beneath both the cystic duct and its vessels divide them between the clamps and subsequently put a ligature round the duct and the cystic artery before removing the lower clamp

The next step consists in stripping the gall bladder from below upwards from the under surface of the liver This is done mainly by the finger, a flap of peritoneum (which need not be more than an inch wide) being cut on either side with scissors Owing to the cystic vessels having been already secured there may be little or no bleeding but as a rule (especially if the gall bladder is inflamed) there is a certain amount of oozing from the under surface of the liver If the gall bladder is distended and thin great care should be taken lest it rupture during detachment When the fundus has been reached the whole viscus is removed and sponge pressure applied whilst the surgeon turns to the ligatured stump of the cystic duct The closure of this may be made more secure by a second ligature or by a fine silk suture the peritoneal cuff being sewn over the closed end of the duct Having made certain that all bleeding has ceased the surgeon sews the peritoneal flaps together in the site of the removed gall

to inclusion of part of the common bile duct and common hepatic duct (Fig 179)



Fig 179 —Illustrating one way in which the common bile duct may be injured during cholecystectomy

III Choledochotomy Incision into the Common Bile Duct

Operation.—The preparation of the patient the instruments the preliminary incision etc, are the same as for cholecystostomy (p 389) If, as is probable jaundice has been present it is most important to lessen the risk of hæmorrhage by giving the patient Vitamin K for a week before operation In serious cases a blood transfusion should be given before operating It is essential to have a firm sandbag behind the patient s loins and after the abdomen is opened the

of gauze in addition to or in place of, the tube a cigarette drain is a convenient form of drainage as the gauze may be removed after twenty four hours and the drainage tube after four or five days

Comment —Cholecystectomy especially if the patient is very stout or if the gall bladder is inflamed thickened, and adherent may prove an exceedingly difficult operation It takes much longer to perform than cholecystostomy, and there is an appreciable risk of damaging the hepatic or the common bile duct the latter of which has even been ligatured instead of the cystic duct Hence great care is required in clearly exposing the cystic duct and in order to provide better exposure another incision through the abdominal wall than that given above is advocated This consists in a vertical incision just to the right of the middle line opening the rectus sheath from ensiform cartilage to the umbilicus to this is added a horizontal one across the right rectus from the lower end of the vertical incision The muscle is then sutured to the anterior layer of its sheath and the triangular flap (including skin sheath and upper segment of the rectus) is reflected and retracted upwards and to the right The posterior layer of the sheath transversalis fascia and peritoneum are now incised obliquely downwards and outwards to the outer angle of the wound This gives free access and when the different layers are separately sutured at the end of the operation the operator has no fear of a weak scar resulting Moreover the nerves to the rectus have not been damaged

Excision of the gall bladder is much more certain to prevent recurrence than removal of the gall stones and drainage the convalescence is shorter and the risk of cancer supervening in the gall bladder is removed

The gall bladder may be excised by working from its fundus towards the cystic duct but in this case hæmorrhage may be troublesome and it is much better to secure the cystic artery early on

There is also danger to the common duct in that traction on the gall bladder when clamping the cystic duct may lead

denum from the front of the right kidney Great care is required in dealing with this lower part of the duct, owing to the close relation of the portal vein (behind the duct) and the hepatic artery to its left The superior pancreatico duodenal artery (a branch of the hepatic) may give trouble The lowest inch or more of the duct is practically inaccessible from above, it can only be reached through the duodenum

In most cases of impacted calculi however the stones can be reached through an incision made in the axis of the duct where it lies between the layers of the gastro hepatic omentum—i e above the duodenum The incision is usually made directly over the calculus the duct being steadied and held forward with the left hand the incision should be long enough to admit the index finger It is a good plan to pass two suture loops through the duct wall just above and below The surgeon s little or index finger is if possible introduced through the wound in the duct and exploration made for any other stone Desjardins forceps is particularly useful for this purpose and should be passed both upwards and downwards within the lumen of the duct

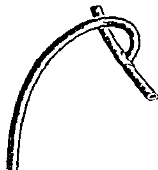


Fig 181 —T tube for use in choledochotomy

In most cases the surgeon decides to drain the duct by a long tube introduced into its upper part through the wound and held in position by a catgut stitch A T tube (Fig 181) is most serviceable and the opening in the duct is readily closed over it by means of a few interrupted catgut stitches The tube is brought out of the abdomen and thus for ten to fourteen days (until it becomes loose and is removed) all the bile flows outside the abdomen into a bottle Before the T tube is removed the patency of the passage into the duodenum may be proved by noting the colour of the stools by noting the effect of clamping the tube overnight or by injecting

assistant should draw the liver and costal edge well upwards so as to expose and straighten out the biliary ducts

For the best incisions see p 390

Adhesions of the gall bladder and liver to the stomach or duodenum if present must be carefully separated and the gall bladder is drawn upwards with the liver If the gall bladder is felt to contain calculi it is opened and the calculi are evacuated After the fluid has been let out the opening should be guarded by sponges or gauze held in place by an assistant whilst the operator traces down the cystic and common bile ducts With finger and thumb he ascertains the position and number of calculi present in the common duct If possible the left index finger should be passed through the foramen of Winslow A frequent place for impaction in the duct is just above the orifice into the duodenum where the duct is somewhat dilated, forming the ampulla of Vater (Fig 180) It will be remembered that the duodenal orifice is the narrowest part of the duct and that it is situated at the inner and posterior aspect of the second part of the duodenum Besides the ampulla of Vater there may be another dilated portion of the common duct in which calculi are apt to lodge immediately below the junction of the cystic and hepatic ducts In tracing down the common bile duct in its lower half some assistance will be obtained by slightly detaching and depressing the duo

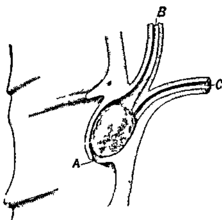


Fig 180 —Section of duodenal wall

Showing at A the papillary opening of the biliary and pancreatic ducts (B and C) A calculus is firmly lodged in the ampulla of Vater

long and situated on the anterior wall about 2 inches from the pylorus

Note —It is impossible here to discuss all the modifications which are occasionally employed in operating on the gall bladder and the biliary ducts

V SPLENECTOMY

Trauma is by far the commonest reason for splenectomy The organ is also removed in familial acholuric jaundice and in *certain cases of chronic essential thrombocytopenic purpura* Rarely it is removed because of obscure blood disorders (hypersplenism) or because of its large size

Operation —A stomach tube should be passed to deflate the stomach of air The incision is a left paramedian with a transverse bar if necessary Large spleens can be removed through a subcostal incision It must be remembered that the spleen has two pedicles (Fig 182) the splenic artery running behind the peritoneum in the lieno renal ligament and the vasa brevia or short gastric vessels in the gastro splenic

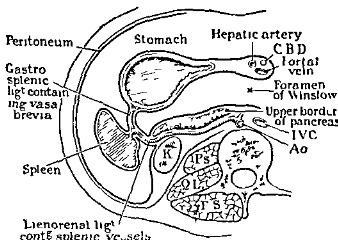


Fig 182 —Transverse section through upper part of abdomen

lipiodol into the tube and taking an X ray (cholangiogram) A tube as thick as the index finger goes down to the site of the incision in the bile duct as an extra precaution and will be removed on the third or fourth day

TRANSDUODENAL CHOLEDOCHOTOMY

If a calculus be detected in the ampulla behind the duodenum the following course should be adopted The descending portion of the bowel should be incised and its lumen immediately cleansed with sponges While the edges of the intestinal wound are held apart by an assistant with the aid of stitch retractors the operator steadies the calculus with the fingers of the left hand and incises the inner and posterior wall of the duodenum as closely as possible to the opening of the common bile duct As some museum specimens show a large calculus may be found wedged in the actual orifice and in such a case it may not be necessary to incise the posterior wall of the gut in order to liberate the stone (Fig 180)

Mayo Robson states that sutures need not be placed in the small posterior wound but that the main incision into the duodenum should be accurately closed by a double row of stitches one uniting the mucous membrane and the other the outer coats The abdominal wound is sewn up in the usual manner and drainage is unnecessary unless doubt is felt as to perfect closure of the intestinal wound The mortality attending this operation is said to be about 12 per cent

IV CHOLECYSTGASTROSTOMY

By this term is understood the establishment of a fistula between the gall bladder and the stomach for relief of obstructive jaundice due to malignant or traumatic stricture of the bile duct

Operation —The gall bladder is emptied by aspiration and then anastomosed to the stomach or duodenum with the aid of curved clamps and two continuous catgut sutures The technique is precisely the same as that for gastro enterostomy The opening into the stomach should be 1 inch

CHAPTER VIII

OPERATIONS ON THE KIDNEY AND BLADDER

The following operations will be described —

1 Nephro lithotomy or incision of the kidney or its pelvis for stone
2 Nephrectomy or removal of the kidney
3 Nephropexy or fixation of a movable kidney
4 Nephrostomy
5 Uretero-lithotomy
6 Pyeloplasty or plastic operation on the renal pelvis
7 Suprapubic cystostomy
8 Suprapubic prostatectomy
9 Retropubic prostatectomy

Before a patient is submitted to any operation on the genito urinary system a certain pre operative ritual must be rigorously carried out

I **A thorough clinical examination** of the patient paying particular attention to the heart blood vessels blood pressure, etc

II **A routine examination of the urine**

III **X-ray examination**

(a) In cases of stone both antero posterior and lateral *skiagrams* must be taken Uric acid calculi (rare) do not cast a shadow

(b) *Pyelography* —Here the pelvis of the kidney is filled via a ureteric catheter with about 8 c c (its normal capacity) of sodium iodide solution (13 per cent) and a skiagram taken Filling defects will be observed as well as other shadows in relation to the pelvis It should be noted that over filling the

ligament The usual operation described is to pass the hand behind the spleen and turn it forwards Adhesions between the organ and the diaphragm are usually thin but may have to be divided with long scissors The space opened up is packed with a roll of gauze Behind the spleen the splenic vessels can be seen the vein is often the size of a thumb in some blood diseases These vessels are ligatured with thick thread or silk individually The tail of the pancreas is carefully peeled off the pedicle The vessels in the gastro splenic omentum are now ligated being careful not to tie them too close to the stomach or troublesome hæmorrhage may result

For very large spleens it is a good plan to tie the splenic artery in continuity as it runs above the pancreas behind the peritoneum It is found by opening the lesser sac through the gastro hepatic or gastro-colic omenta thus revealing the pancreas covered by peritoneum The vessel can be demonstrated by palpation and an aneurysm needle carrying a stout ligature may be passed round it If the splenic pedicle is subsequently torn or the spleen damaged any dangerous bleeding can be averted

If the spleen is firmly attached to the diaphragm by adhesions due to perisplenitis the spleen must be approached from the front The gastro splenic omentum is divided and ligatured and the anterior layer of the pedicle is incised to reveal the splenic vessels These are tied serially with stout thread or silk

similar needle holder suitable for holding small curved needles A small *periosteal elevator* may be useful in detaching some stones Very rarely an exploring needle may be required

STEPS OF THE OPERATION

1 **Exposure of the kidney** —The patient lies upon the sound side as near to the edge of the table as possible The loin of the affected side is well exposed and to widen the interval between the last rib and the crest of the ilium a pneumatic cushion should be placed under the loin of the sound side The patient s arm on the affected side is held away from the chest supported by a special hollowed metal rest which is fixed to the operating table In this way the respiration is unimpeded by the weight of the arm

Some operators in this and other operations on the kidney, prefer the completely prone position of the patient with a cushion beneath the trunk We have not found it so convenient as that described and it obviously may interfere with respiration but it is useful if both kidneys must be exposed as in decapsulation

The surgeon stands by the patient s back leaning over the trunk. An assistant stands on each side of him to sponge and assist in retracting the wound A third assistant is placed on the other side of the table opposite to and facing the surgeon His chief duty is to press the kidney towards the loin when the organ has been exposed

The twelfth *rib should be definitely recognized* and well defined It is occasionally absent or rudimentary and then the pleural sac descends below the eleventh rib which (unless the precaution is taken of counting the ribs from above) may be mistaken for the twelfth

An oblique incision is made across the costo iliac space The cut commences about half an inch above the last rib and close to the outer border of the erector spinæ which can usually be felt about 3 inches outside the vertebral spines It is continued downwards and forwards towards the crest of the ilium (Fig 183) Its length must depend upon the space available and upon the depth of the tissues of the loin

renal pelvis causes pain and this is the guide in injecting the fluid

It is possible to secure similar results by the intravenous injection of diodone (50 per cent) a substance rich in iodine and therefore radio-opaque which is selectively excreted by the kidneys In children this may be injected intramuscularly in doses of 1 c c per year of age

IV Renal-efficiency tests

(a) *Urea meal* —15 gm of urea dissolved in 100 c c of water is given to the patient who has been previously deprived of water for six hours The urine is collected every hour for three hours the last two specimens being the important ones The urea is estimated by the hypobromite method 2 5 per cent is a normal figure below 2 per cent moderate with 1 per cent or below the patient will not survive six months and no operation should be performed

(b) *Blood urea* —The normal is 25-40 mg in 100 c c, above 60 mg is getting near the danger zone

(c) *Indigo carmine* —10 c c of a 0 4 per cent solution is injected into the glutei muscles or into a vein and a cystoscopic examination carried out The ureters will be seen to squirt the dye across the field about twelve minutes after the injection if the renal function is normal absence of efflux means either a damaged or an absent kidney

V Cystoscopy —Much valuable information concerning the ureters and the state of the bladder wall will be gathered from this examination

I NEPHRO LITHOTOMY

Special instruments required —Large curved and rectangular metal retractors long bladed tenotome suitable probes and scoops the smallest-sized bladder sound Lister s sinus forceps gall stone forceps Halsted s or some

be seen branches of the last dorsal nerve and last intercostal artery and nearer the iliac crest, the first lumbar nerve and a branch of the last lumbar artery Division of the nerves should be avoided if possible, if not, suture loops should be attached to their ends so as to unite them again at the close of the operation

Both muscle and aponeurosis are divided to the full length of the wound No director should be employed and any bleeding points which give trouble may be ligatured, as pressure forceps are apt to be in the way It is however, very rarely that there is any need for a ligature at this stage

As each layer of tissue is divided the several parts are retracted by means of broad rectangular or slightly curved metal retractors The close proximity of the ascending or descending colon has to be remembered and it often has to be pushed outwards with the finger

The fascia transversalis is now reached and divided, when the perirenal fatty tissue is exposed It should be remembered that the kidney and perirenal fat are enclosed within a special sheath derived from the fascia transversalis this sheath is quite distinct from the true kidney capsule

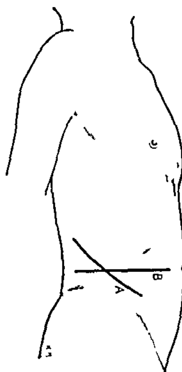


Fig 184 —Alternative methods of exposure of kidney
A —Extraperitoneal
B —Transperitoneal

The retractors are made to take up the whole of the severed structures down to the exposed fatty capsule and the depths of the wound are laid open to the utmost

After the skin superficial fascia and fat are divided the outer border of the latissimus dorsi and the hinder border of the external oblique muscles are exposed The fibres of both are almost vertical the external oblique running downwards

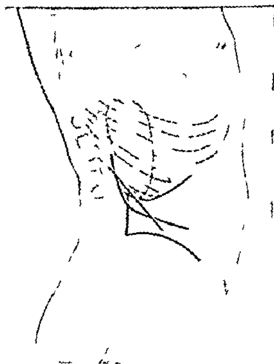


Fig 183 —Incisions for exposure of kidney lateral view

and forwards the latissimus upwards and forwards Hence the incision (Fig 183) will cut across few of the fibres of either The sheath of the erector spinæ muscle should not be opened The internal oblique muscle and the posterior aponeurosis of the transversalis muscle (fascia lumborum) are now laid bare The fibres of the former muscle run upwards and inwards Piercing the fascia near the rib there may

impossible to feel a small stone deeply embedded in the renal substance If the stone is felt at this stage either in the pelvis or directly beneath a thinned patch of cortex, it should be extracted The kidney is steadied and an incision is made directly on to the stone preferably through the pelvis in the line shown in Fig 185 The stone is gently enucleated with the finger caught between the finger and a scoop and brought out of the wound, if possible unbroken

The surgeon then satisfies himself by palpation or even by the passage of a bougie down the ureter that there are no more stones and closes the small wound in the cortex or pelvis with a few catgut sutures This can be very easily accomplished by means of Halsted s needle holder and fine curved needles



Fig 186 —Transverse section of kidney to show correct direction of incision so as to strike the front of the posterior calyx and to avoid large vessels

It is best to bring the kidney out of the wound in order to locate and extract the stone This may be difficult in the case of the right kidney as the right renal vessels are much shorter than the left Other factors which make the delivery of the kidney difficult are massive adhesions an aberrant renal artery great obesity and a horseshoe kidney

The object of the operator is to explore the interior of the pelvis and the calyces for most calculi are embedded either within the pelvis or in a calyx that is hollowed out to contain the stone which is restrained from dropping into the pelvis by the narrow neck at the junction of calyx and pelvis The kidney substance is often thinned out over the stone, with the formation of a cyst or abscess The incision

The perirenal fat is now opened up with the forceps and finger and the kidney is reached and laid bare In order to bring it well into the field of the operation an assistant should press the anterior wall of the abdomen with the palms of both hands towards the exposed loin, thus pushing the kidney towards the wound

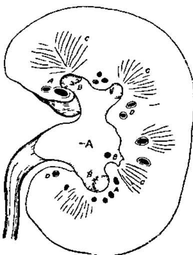


Fig 185 — Vertical section through long axis of kidney

The dotted line passing through the upper end of the ureter and into the pelvis indicates the best incision for reaching calculi in the latter or in one of the calyces (B) A section through the convexity of the cortex is seen to divide a number of arteries and veins of considerable size A A columns of Bertin large vessel cut across C pyramids of Malpighi

Through the free opening made in the perirenal fat the finger is introduced and the whole kidney systematically examined

If long standing inflammation has been present the surrounding tissues will be confused will be matted together and will offer a more or less firm resistance to the exploring finger The kidney should be delivered one pole at a time first the lower pole which is prevented from retracting back into the wound by placing a large gauze swab behind it and then the upper pole

2 **Detection and removal of the stone** — The use of skiagraphy has simplified both these procedures By this means the exact position size and roughly the number of calculi present in the kidney (for they are often multiple) can be determined beforehand

It is understood that the surgeon has exposed the back of the kidney and confirmed the probable position of the stone as shown by the skiagraph It is often very difficult if not

nephrectomy and even led to the patient's death Again bisection of the kidney probably has a serious effect upon its subsequent utility, and the leakage of urine from it may be troublesome

The idea on which section through the cortex is based is that such wounds heal more readily than those made through

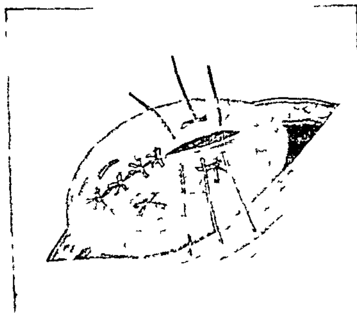


Fig 188 —Exploration of kidney method of closing incision

the pelvis but the latter whether sutured or not soon close up As a general rule the incision should run in the dotted line A in Fig 185 or a continuation of it Such an opening is well adapted for exploring the whole of the pelvis with finger or sound Of course if the skiagram has revealed a small calculus near the cortex and far from the pelvis the surgeon should cut down directly over it If the operator thinks it necessary to make a vertical incision into the pelvis through the cortex he should follow the so called

should always be long enough to admit the finger and should be placed directly over the stone It is frequently advisable to encroach on the renal tissue in which case the wound should radiate from the hilum parallel with the main vessels It should not be forgotten that a branch of renal artery or vein may be present behind the pelvis and care should be taken to avoid wounding it

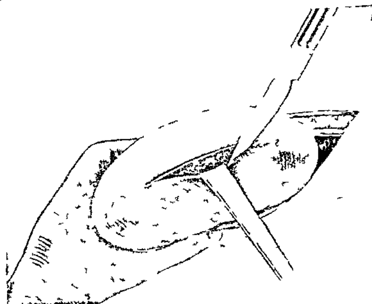


Fig 187 —Nephrotomy pedicle compressed by thumb and fingers

The plan of entering the pelvis through a large wound made through the outer border of the kidney (i e splitting the organ vertically into two halves) has been extensively advocated but is to be avoided for the following reasons As shown in Fig 183 such an incision must pass through a considerable thickness of the gland and will probably divide several important vessels in fact the hæmorrhage following bisection of the kidney has in some cases necessitated

nephrectomy and even led to the patient's death Again bisection of the kidney probably has a serious effect upon its subsequent utility and the leakage of urine from it may be troublesome

The idea on which section through the cortex is based is that such wounds heal more readily than those made through

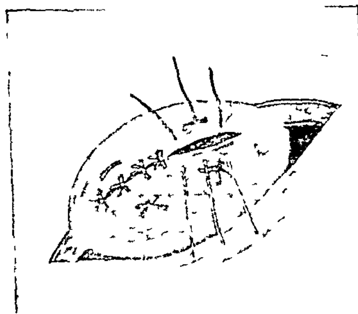


Fig 188 —Exploration of kidney method of closing incision

the pelvis but the latter whether sutured or not soon close up As a general rule the incision should run in the dotted line A in Fig 185 or a continuation of it Such an opening is well adapted for exploring the whole of the pelvis with finger or sound Of course if the skiagram has revealed a small calculus near the cortex and far from the pelvis the surgeon should cut down directly over it If the operator thinks it necessary to make a vertical incision into the pelvis through the cortex he should follow the so-called

should always be long enough to admit the finger and should be placed directly over the stone It is frequently advisable to encroach on the renal tissue in which case the wound should radiate from the hilum parallel with the main vessels It should not be forgotten that a branch of renal artery or vein may be present behind the pelvis, and care should be taken to avoid wounding it

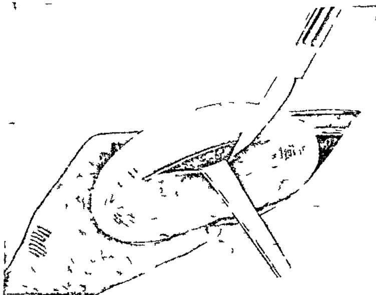


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Nephrectomy may be performed in two ways —

1 By incision through the loin—*lumbar nephrectomy* This is the method of choice, and the one almost invariably employed

2 By incision through the anterior abdominal parietes —*abdominal nephrectomy* used for large growths especially in children

I LUMBAR NEPHRECTOMY

Special instruments required —Large pressure or clamp forceps straight and angular, broad metal rectangular retractors blunt hooks stout aneurysm needle with a long handle pedicle needle

The **position** of the patient and of the operator and assistants is the same as has been already described (p 405) The use of a hard pillow placed under the loin is advised in order to extend the space between the last rib and the iliac crest

Exposure and isolation of the kidney — The incision recommended is an oblique one starting over the last rib just outside the erector spinæ and running downwards and forwards to near the iliac crest (Fig 183)

When the organ is reached and has been superficially examined it will usually be found necessary to enlarge the original incision This may be done in various ways

The oblique incision may be extended at its lower end about one inch above the iliac crest parallel to the latter as far as is found necessary

The kidney is exposed in the manner already described

It is now necessary to examine it and separate it from its connexions Broad retractors should be used so as to expose the parts well and an assistant should at the same time press the kidney into the wound by the hands applied over the front of the abdomen If there has been no inflammation in the perinephric tissue the separation of the kidney is easy

The fatty tissue around the kidney can readily be detached by means of the index finger of one hand introduced into the

'bloodless line' or plane of Max Brodel which is situated about the junction of the anterior three fourths of the renal thickness with the posterior fourth (Fig 186)

With regard to the *removal* of the stone, a pair of small lithotomy forceps or a scoop aided by the surgeon's finger will answer the best

The object of the surgeon should be to remove if possible the calculus without breaking it and with the *infliction* of the minimum of injury to the pelvis or the renal substance If however the stone be large and irregularly branched it may be found necessary to break it up into two or more fragments and to remove them separately so as to avoid undue laceration of the kidney Such removal should be followed by a free irrigation of the part with warm sterilized water As a rule under these conditions—i e a large branched calculus—it is useless to attempt removal of the stone for secondary nephrectomy will then become necessary The kidney is probably disorganized and not worth leaving

3 **Closure of the wound** —The wound in the kidney is closed by carefully placed mattress sutures (*Fig* 188) A rubber tube of fair size should be inserted One end of the tube should be in contact with the kidney while the other end of it is secured in place by a suture This tube should not be removed too soon—i e not until the discharge if any has entirely ceased Deferred inflammation or suppuration is particularly apt to occur in connexion with kidney wounds

II NEPHRECTOMY

The operation of removing or excising the kidney has been performed for tumour of the kidney for renal or ureteral fistula and for disorganization of the organ by injury tuberculous disease calculi suppuration etc

Before proceeding to remove one kidney it is essential to determine that the opposite organ is acting normally The X rays will usually show its presence and size but its power of secreting can only be ascertained by catheterizing its ureter from the bladder with the aid of the cystoscope and examining the urine drawn off

later Such hæmorrhage may depend upon the existence of aberrant or abnormal branches that have escaped the ligatures on the pedicle

The ureter is then examined If it appear healthy it is left as it is securely ligatured If it be dilated and occupied by foul or tuberculous pus then as much of the tube as can should be excised above a ligature applied as low down as possible the remainder will be removed at a subsequent operation

The frequent existence of abnormal veins and arteries must always be borne in mind These vessels may escape the clamp or the ligature and yet be severed when the kidney is removed In more than one recorded case fatal hæmorrhage has resulted from this cause

The wound in the parietes is now closed by sutures These should be of interrupted catgut for the deep structures and of stout silkworm gut for the skin A drainage tube—by choice a spiral one—should be inserted and fixed in place by a suture passed through the skin It should be kept in for several days—as long as there is any kind of discharge

2 ABDOMINAL NEPHRECTOMY

Operation —Abdominal nephrectomy is only employed for injury to the kidney when other abdominal lesions are suspected and in large growths of the kidney (Fig 183) In very large growths the paramedian incision is used The intestines are packed off and the colon mobilized inwards the renal pedicle is dealt with as in lumbar nephrectomy

Note —Abdominal nephrectomy has the drawbacks that the nerve supply to the rectus muscle is unavoidably damaged and that however carefully the parietal wound is sewn up a long scar in this position is almost sure to result in ventral hernia The procedure therefore is only justified when the renal tumour is too large to allow safe removal by the lumbar route

III NEPHROPEXY

This operation is practised in cases of floating movable or wandering kidney in which the organ is the seat of severe and spasmodic attacks of pain due to kinking of the ureter It is also employed in special cases in which there is more or

depths of the wound and swept round the organ in close contact with its capsule In this manner the gland is readily enucleated and isolated

When there has been much inflammation as in cases of calculous or tuberculous pyonephrosis the tissue surrounding the kidney will be found condensed and adherent and the enucleation of the organ will then be difficult, or in some few cases impossible In such case the kidney should be enucleated from its thickened and firmly adherent capsule and the latter left behind with the pedicle In effecting this enucleation a flat hernia director will be found of service

Treatment of the pedicle —The kidney having been freed is drawn as far out of the wound as possible and the pedicle is isolated with the fingers and examined carefully To obtain more room the lower ribs may be drawn forcibly upwards with a strong retractor This is made easy by dividing the external arcuate ligament which connects the last rib to the first lumbar transverse process In making traction on the kidney, special caution is required on the right side as the renal vein here is very short compared with the left one Fatal cases of hæmorrhage from tearing the vein have occurred

The individual structures in the pedicle should be exposed and isolated as far as is possible by dissection The ureter is well isolated and secured between two ligatures The vessels are then secured separately or in as small bundles as possible the arteries first and the veins afterwards Silk or thread is used to secure the pedicle and it is conveniently passed by means of a stout aneurysm needle The ligatures on the vessels should be applied as far from the kidney as possible

As each ligature is being drawn tight all traction upon the pedicle must be taken off

The pedicle is next divided with blunt pointed scissors close to the hilum of the kidney

The kidney is now removed

The pedicle is examined Any bleeding point detected should be at once seized with pressure forceps and secured



Fig 189 —Nephrostomy method of passing the catheter

It is better not to apply stitches at higher levels than these as the upper end of the kidney should usually overlap the twelfth rib when replaced in the wound whereas the stitches are to be placed below that level

The kidney is replaced in its bed which has been entirely stripped of fat and pushed upwards until the vessels appear to be transversely In this way an idea is obtained of the natural level of the organ

At the appropriate level thus determined the ends of the posterior sutures are passed through the quadratus lumborum and tied but not too tightly so as to allow a little play They should restrain firmly rather than fix the kidney The two anterior sutures are passed through the muscles of the outer edge of the incision at suitable levels and tied in similar fashion The anterior sutures are not essential and can be omitted in which case the anterior portion of the stripped capsule should be cut away altogether

All bleeding is arrested and the wound in the parietes closed with drainage

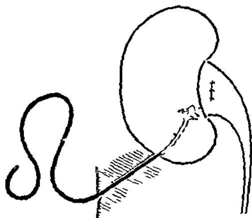


Fig 190 —Nephrostomy the catheter in place

less continuous discomfort and in which all other measures —such as the use of a carefully fitted abdominal belt—have failed

The operation was at one time somewhat indiscriminately employed It should be restricted to the cases in which the kidney really floats i e moves forward in the abdomen as well as vertically A moderate degree of movement in the vertical plane alone can cause no trouble Moreover it is necessary to consider carefully any case of floating kidney before resorting to operation as the result is sometimes very disappointing A highly neurotic patient should as a rule be advised against operation

Operation —The kidney having been exposed from behind as already described (p 405) the perirenal fat is torn away with sponge holding forceps and the kidney and upper portion of the ureter are stripped cleanly and completely from their bed A thorough examination must now be made of the ureter pelvis and kidney to exclude kinks or strictures of the ureter aberrant vessels dilated pelvis stone tuberculosis and other diseases of the kidney which may require further operative procedures The kidney is brought on to the surface for decapsulation An L shaped incision is made with a sharp knife through the true fibrous capsule care being taken to spare the underlying cortex The vertical limb of the incision runs along the convex border of the kidney from one end to the other The capsule is stripped off the cortex so as to lay bare at least half of the anterior and the whole of the posterior surface of the kidney It can usually be peeled off quite readily with the aid here and there of a blunt dissector or the point of the knife except when there has been long standing inflammation Gentle pressure with a hot sponge will quickly put a stop to any excessive oozing from the cortex The capsule is rolled back on each side and four silk or thread stitches are applied to it on curved needles in the following manner two in front and two behind The upper posterior stitch is made to penetrate the rolled capsule from without inwards at the level of the middle of the kidney It is then passed vertically upwards for about an inch and is brought out again from within outwards The two free ends of the stitch are left hanging from the wound and clipped with pressure forceps The lower posterior stitch is next applied in similar fashion through the capsule near the lower end of the kidney The two anterior stitches are applied at the same levels and in the same way

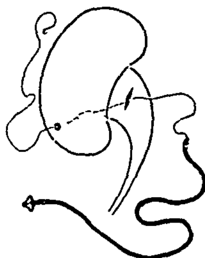


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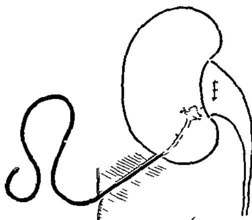


Fig 190 —Nephrostomy the catheter in place

IV NEPHROSTOMY

This operation may be a life saving measure in some cases of renal calculus where suppression of urine has occurred as well as in chronic hydronephrosis and pyonephrosis

The kidney is exposed through a lumbar incision and the lower pole identified and drawn forward to expose the renal pelvis A small incision in the renal pelvis admits a small uterine sound fully curved or a silver probe bent into a U shape which is passed through the lowest calyx and onwards through the renal parenchyma

Along this path is passed a self retaining catheter (Fig 189 190) and the wound in the pelvis is closed

The lumbar incision is closed in layers and the end of the catheter is fitted with an extension which leads to a bottle at the side of the bed

V URETERO LITHOTOMY

The exact determination of the calculus its site and size is of course made by the X rays alone with due regard to the possibility of mistaking calcareous lymph glands or phleboliths for stones It is important to X ray the patient immediately prior to operation since stones may suddenly disimpact and move

A calculus may be impacted at the junction of the renal pelvis with its ureter at the vesical orifice or at any point between these two * Hence no fixed rules can be laid down for its extraction In most cases the stone should be cut down upon in the lumbar region through an incision made as for exploration (Fig 183) commencing at the angle between the erector spinæ and the last rib and passing down to the iliac crest Parallel to the latter this incision may be carried forwards over Poupart s ligament The lower end of the kidney and the pelvis having been identified the calculus is sought by palpation If it can be detected with

* The narrowest part of the ureter is at its vesical meatus, next from the he brim of the pelvic bone and about 2 inches below the posterior site At the latter point its lumen is said to be normally near the lower ⅛ of an inch in diameter

at applied at the same

elvis.

in or near the renal pelvis, the latter is incised, care being taken to avoid any aberrant renal vessels It is quite common to find one or more branches of the renal vessels passing *behind* the upper end of the ureter) A gush of urine ensues, and the finger being introduced, will perhaps succeed in extracting the stone, aided by pressure from below with the left hand A small lithotomy scoop or forceps such as are used in cholecystostomy may be required and the forceps should have a secure grip to prevent the stone from slipping out of its grasp

If the calculus be fixed in the ureter too low down to allow it to be pushed upwards into the pelvis the ureter should be incised in its long axis directly over the stone, which may be reached from the loin as low as the upper part of the iliac fossa If there is reason to suppose that the presence of the stone has produced damage to the wall of the ureter at the site of impaction, it is better to incise the ureter at a higher level through the more healthy wall, and milk the stone up to the opening The very extensive wound in the muscles required for this must be carefully sewn up with buried tendon sutures if a hernia is to be avoided

If however, it is previously known that a calculus is impacted at or near the brim of the pelvis an incision should be made similar to that used for ligature of the common iliac artery This incision is made just above and parallel to the outer half of Poupart s ligament curving upwards and slightly inwards when it reaches the level of the anterior superior spine The abdominal muscles and transversalis fascia are divided in this incision until the subperitoneal fatty layer is reached the peritoneum is then gradually pushed inwards until the ureter is reached as it crosses the bifurca tion of the common iliac artery Its identification will probably be rendered easy by its distension with urine the distended part may measure 2 inches or more in diameter While his assistant presses aside the peritoneum the opera tor opens the ureter longitudinally and after the urine has escaped into a sponge held ready for it passes a bent pair of forceps down to grasp the stone The stone is usually elongated with its long axis of course in the line of the

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* The narrowest part of the ureter is at its vesical meatus, next to this at the brim of the pelvic bone and about [illegible] inches below the renal pelvis. At the latter point its lumen is said to be normally only one eighth of an inch in diameter

tax the resources and patience of the operator to the utmost

It is needless to say that in such unfavourable circumstances no attempt should be made to suture the wound in the ureter but in ordinary cases this may be done with success, and such suturing should be employed as a routine measure In any case due provision should be made for drainage

Finally a stone impacted close to the ureteral orifice is best approached from the bladder, if possible by means of cystoscopy, when the orifice can be dilated or incised sufficiently to allow it to escape into the bladder there it can be crushed with a lithotrite Failing this a suprapubic cystotomy (Fig 191) may be required There are several ingenious methods of cutting down on to the lower end of the ureter The transvesical route as practised by the late Sir John Thomson Walker is very satisfactory

VI PYELOPLASTY (ANDERSON)

The main indications for plastic operation on the renal pelvis are great enlargement with perhaps mechanical obstruction at the pelvic ureteral junction The aims are reduction in size of the pelvis and more rapid emptying of urine into the ureter The procedure requires a very careful selection of cases

The steps of the operation are as follows —

The usual lumbar incision is made and the pelvis is cleared

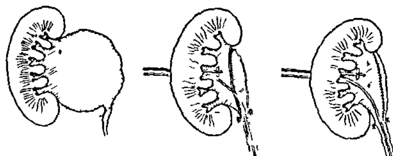


Fig 192 —Serial diagrams of pyeloplasty for hydronephrosis

ureter Should the patient be thin, the ureter will probably be reached with ease and the extraction of the stone may present

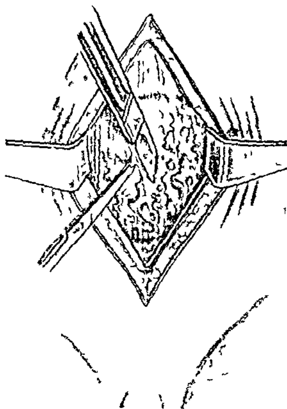


Fig 191 — Suprapubic cystotomy incision of the bladder wall

no difficulty Far otherwise is it if the patient be stout for the search for a small calculus at a depth of some 3 inches of fat from the surface whilst venous oozing is continuous may

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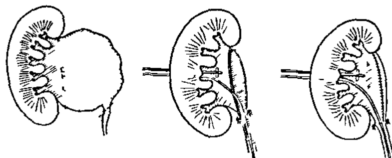


Fig 192 —Serial diagrams of pyeloplasty for hydronephrosis

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and carefully inspected for any primary cause for the enlargement The existence of adequate renal parenchyma is then ascertained Enough renal pelvis is excised to reduce the size of the cavity making sure that the lowest part of the opening is opposite the lowest part of the pelvis A temporary nephrostomy is made with a small (Size 14) Malecot catheter and a ureteric catheter is used as a splint passing through the nephrostomy opening and into the ureter

The ureter is divided very obliquely and united to the lower open part of the pelvis with fine (3/0) plain catgut using interrupted sutures which evert the mucosa The upper part of the pelvis is then closed with a continuous suture with a few additional tacks near the anastomosis A nephropexy is then done to fix the kidney the vascular pedicle of which has been stretched by the pelvic dilatation The wound is then closed with drainage

VII Suprapubic Cystostomy

The indications are —

1 As a treatment for retention of urine due to prostatic obstruction when the patient cannot be made fit enough for prostatectomy
2 As a temporary drainage after removal of a vesical diverticulum or tumour
3 In the treatment of bladder rupture

If the bladder is not distended a catheter is passed and the bladder is washed out with warm boric lotion about 1? ounces being left in the bladder and a spigot inserted in the catheter A midline suprapubic incision 4 inches long is made and the recti separated The pyramidalis muscle may cause confusion in the lower part of the wound The peritoneum is defined as it is reflected off the bladder and is pushed upwards with the fingers as far as possible The bladder is recognized by the plexus of veins upon it and its pinkish yellow colour Packs are placed around the bladder which can be opened by a small stab incision which is plugged by the finger until a Thomson Walker tray is placed in *position* so that the fluid is allowed to drain by an attached tube into a pail A self

retaining catheter is then passed into the bladder which is sewn tightly around it with catgut sutures

A more elegant method is to plunge a large trocar and cannula through the apex of the distended bladder The trocar is withdrawn and the cannula sealed with a finger A self retaining catheter of De Pezzer or Malecot pattern is stretched on an introducer and quickly inserted into the cannula into the bladder The cannula is then withdrawn and the contracted bladder effectively seals itself round the tube

The rectus sheath is closed with interrupted catgut sutures and the skin with interrupted nylon or thread A skin suture transfixes the tube to anchor it

Comment Whatever method is used it is important to push up the peritoneum to avoid injuring it

The opening into the bladder should be made as high as possible to prevent the bladder and sinus track contracting down behind the symphysis

The sinus track should be a long oblique one and, ideally the cutaneous opening should be half way between the symphysis and umbilicus The skin suture fixing the tube should be placed with due regard to the fact that the bladder will become smaller as it empties Too short an internal tube length may cause it to drag out of the empty bladder

When the tube is finally removed the sinus may be covered by an Irving's Box In any case the tube needs changing once a fortnight

VIII Suprapubic Prostatectomy

The first part of the operation is to expose and open the bladder as described in the previous section The bladder incision is increased to admit the hand and the right index finger is pressed against the posterior lip of the internal meatus the line of cleavage between the middle and lateral lobes is opened up and the finger swept first right and then left until the main mass of the gland is free in its capsule It only remains now to snap its connexion with the membranous urethra when this is done the prostate is removed

and the patient placed in the Trendelenburg position All tags are snipped off from the periphery of the prostate bed and a hæmostatic suture is placed round the posterior two thirds of the shelf These manœuvres are aided by using a good head light A drainage tube is placed in the bladder free of the trigone and a small drain in the prevesical

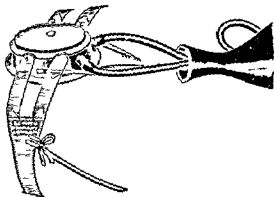


Fig 193 —Hamilton Irving apparatus

space of Retzius The bladder is sewn up with interrupted catgut sutures and the wound closed in layers short of the drainage tubes A catheter is tied in and the patient put to bed Frequent lavage is instituted and is much facilitated by the use of Hamilton Irving s box (Fig 193)

Modifications —

(a) Some surgeons operate through a transverse skin incision
(b) The prostate cavity may be packed with ribbon gauze to act as a hæmostat This is removed in a few days time
(c) In Harris s method the prostatic cavity is obliterated by suture using a boomerang needle A deep stitch is also placed in the centre of the trigone between the ureteric orifices to form a groove in the base of the bladder leading into the prostatic urethra

IX RETROPUBIC PROSTATECTOMY

Introduction —The retropubic approach to the prostate gland via the Cave of Retzius was introduced by Terence Millin in 1945 It seems to possess certain advantages over the Harris type of Suprapubic Prostatectomy, a smoother and shorter convalescence early ambulation, brief period of catheter drainage (3-5 days against the 10-14 usual in a Harris type operation normal micturition is therefore established early) and freedom from post-operative complications e g persistent suprapubic urinary fistulæ The operation is indicated principally in cases of prostatic hypertrophy due to simple senile adenomata but early carcinoma and calcareous prostates are easily enucleated by this route

Preliminaries —A cystoscopy is essential to confirm the diagnosis and exclude disease of the bladder—inspection of the bladder is not advised at the operation The bladder is left empty

Incision —The operator stands on the left side of the patient A subumbilical midline incision is the most convenient commencing 1 inch above the symphysis pubis and 3 or 4 inches long according to the build of the patient The rectus sheath is opened and the muscles separated in the line of the skin incision In thin subjects a transverse skin incision 1 inch above the symphysis and 4 inches long gives an excellent cosmetic result but the exposure obtained is not always satisfactory in fatter patients The skin flaps are undermined and the rectus sheath may be opened either vertically or in the line of the skin incision The muscles are separated as before

Approach —The transversalis fascia is incised at the lower end of the wound—in most cases a finger can break through easily Using the fingers the prevesical space is entered and the peritoneum stripped up off the bladder A self retaining retractor is inserted to expose the prevesical space With small swabs held in forceps or the fingers as necessary the peritoneum is swept up from each side of the prostatic capsule and the fat over the capsule is wiped upwards

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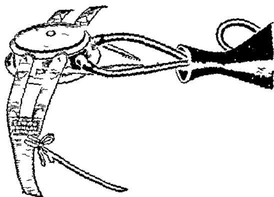


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the V is at the bladder neck Great care must be taken at this stage to identify and avoid ureteric orifices

Toilet of Prostatic Cavity —The pack is removed from the prostatic cavity (also if used the two lateral packs are taken out) and the cavity examined for odd tags of tissue and small adenomata These are removed with the diathermy needle and spurting vessels are caught in hæmostats and coagulated There is usually a definite 'spurter' at seven o clock and again at five o clock on the floor of the cavity near the bladder neck Attention is directed to the prostatic *bed* and not to the cut edges of the capsule

Closure —When hæmostasis is satisfactory a Foley catheter is passed per urethram, and should slide easily through the excised trigonal wedge into the bladder The prostatic capsule is repaired with a continuous suture of No 2 Chromic Catgut using a Boomerang needle Care is taken to close the corners of the incision This suture is hæmostatic if deep bites are taken and bleeding from the prostatic capsule is readily controlled The bag of the Foley catheter is blown up with sterile water 20 ml of water into a 30 ml bag is recommended The bladder is sucked dry using 2 oz of 1 10 000 Silver Nitrate solution and a Riches glass barrelled bladder syringe to irrigate the catheter The bladder must be freed from all clots The 2 oz of irrigating fluid should be no more than a clear pink when sucked back into the syringe If it still contains clots and fresh blood, then it is clear that hæmostasis is unsatisfactory and there are two courses open In severe cases the prostatic bed must be exposed again and a bleeding vessel sought for and coagulated with the diathermy This should be an exceptional happening—it means that the operator was too hasty in declaring that the prostatic bed was dry ! It will be sufficient in almost every case to place a firm pack in the prevesical space down on to the prostatic capsule This can be removed in twenty four hours no anæsthetic being necessary Even this simple step is very unusual once a little experience of the operation has been gained A drain is put down to the prevesical area and the abdominal wall closed in layers

towards the bladder Care is required as the veins of the prostatic plexus are exposed They are coagulated using the diathermy or if very large are underrun with a Boomerang needle and cut between ligatures If the prostate is small a pack is placed in each lateral recess in order to steady the gland

Having cleaned the capsule the junction of the gland and the bladder is identified by touch and appearance The circular muscle fibres of the bladder neck are usually clearly visible With a diathermy needle the prostatic capsule is incised half an inch distal to this junction over the lateral lobes of the gland from side to side Spurting vessels are caught and coagulated as the incision is deepened until the white adenomatous tissue is seen throughout its length

Enucleation.—All instruments and retractors are removed and the right index finger feels for the line of cleavage between the false capsule and the adenoma Commencing from below the gland is freed all round The membranous urethra may be rubbed through with the finger and thumb as it enters the gland in most cases but if rather tough it is better to cut it across deliberately with long curved blunt pointed scissors The gland now freed below at its apex is drawn up into the wound Usually the finger can free the subtrigonal part whereupon the gland may be removed out If the subtrigonal extension is large as when there is a prominent middle lobe it is necessary to free it under vision A gauze roll is packed into the prostatic cavity to control the bleeding and the self retaining retractor replaced The field is sucked dry and the gland held up with volsellum forceps It will be adherent more or less firmly to the bladder neck The circular muscle fibres of the internal sphincter are wiped off with gauze and the mucosa either rubbed through or cut with the diathermy needle according to circumstances The gland is then quite free

Excision of Trigonal Wedge – The posterior lip of the vesical inlet is now pulled up by a pair of long artery forceps and a V cut out of it by the diathermy needle The base of

3. The incision in the prostatic capsule may be made longitudinally into the bladder neck instead of transversely.
4. Any sort of catheter may be used and kept in place in many different ways.
5. The catheter may be removed as early as the third day.

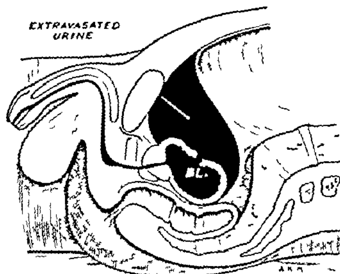


Fig. 195. Extraperitoneal rupture of the bladder

Extraperitoneal Rupture of the bladder involves its anterior wall or base (Fig. 191). The urine finds its way into the pelvic cellular tissue and gives rise to a most virulent form of suppurative pelvic cellulitis which is usually fatal from toxaemia or pyaemia. Abscesses generally point either above the pelvic brim or in the perineum. The treatment consists in free incisions into the area of extravasation and a large suprapubic tube should be introduced into the bladder through which the urine can escape freely for a time. As soon as the tissues are sealed off by the development of granulations the tube may be withdrawn.

Bilateral Vasectomy —A bilateral vasectomy is performed to prevent the possible complication of epididymitis

NOTE —The bladder is completely closed, drainage being through the urethral catheter only A Foley catheter is used because it is such a comfortable and trouble free method for keeping a catheter in place The distended bag lies freely in the bladder and is not in any way an aid to hæmostasis

After Care —The catheter is allowed to drain into a bottle hanging beneath the bed, through a length of sterile rubber tubing There is no need to irrigate the catheter whilst drainage continues satisfactorily but if it does become blocked 2 oz of 1 10 000 Silver Nitrate solution are used to irrigate the catheter and the bladder is sucked clear using a Riches syringe as before Emphasis is on the SUCTION and not the injection of fluid No more than 2 oz of fluid is ever put in the bladder at a time

An Intravenous Glucose saline infusion of 2 litres is given routinely blood transfusion may be necessary in some cases A course of Penicillin 200 000 Units 8 hourly for five days is always given The patient may sit out of bed on the third post operative day if he feels like it This is usually the case The urine should be clear by then but if it is not another day in bed is indicated The catheter and prevesical drain are removed on the fifth day Normal micturition follows in almost every case

The stitches in the suprapubic wound are removed on the twelfth day when the wound is dry and soundly healed The patient is usually fit for discharge on the sixteenth day

Modifications —Various minor modifications have been suggested

1 The prostatic capsule may be incised with a scalpel instead of the diathermy needle
2 The line of cleavage between the false capsule and the adenoma may be found with the blunt points of the curved Mayo scissors and the flaps dissected up from the adenoma These may then be caught with Millin's special capsular forceps which secure hæmostasis from the cut edges or they may be held up by stay sutures

cremasteric covering of the cord must be opened in order that the hernia sac may be reached The ilio inguinal nerve will be found lying on the internal oblique and cremaster muscles and should be avoided The sac will usually be

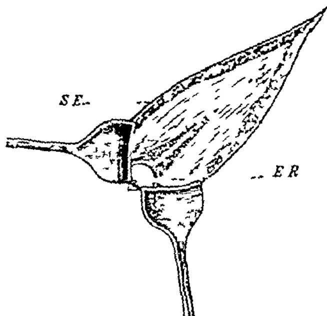


Fig 195 —Radical cure of inguinal hernia

Incision over the left inguinal canal ending below at E.R the external ring The weak portion of the aponeurosis is shaded the dotted line passes through this and indicates the cut made in the external oblique S E. Superficial epigastric vessels divided

found towards the front of the cord (*see* p 432) and if empty is distinguished by its white colour and well defined edge from the connective tissue etc which surrounds it

Method of dealing with the hernial sac and its contents —Two rules may be laid down First the contents of the sac must be wholly returned within the abdomen second the sac itself must be isolated right up to the internal ring transfixed ligatured and cut away Little difficulty

PART IX—OPERATIONS ON HERNIA

CHAPTER I

THE RADICAL CURE OF HERNIA

As operations performed for the radical cure are now far more numerous than those for actual strangulation, it is best to consider the subject of radical cure first

Radical Cure of Inguinal Hernia

The incision —The penis and scrotum thighs and upper part of abdomen are protected with sterilized towels Only the region just above Poupart s ligament requires to be exposed as the incision is placed here whether the hernia has descended to the bottom of the scrotum or not

The operator feels for the pubic spine, and identifies the position of the external ring and Poupart s ligament His incision runs for 3 or 4 inches parallel to and above the ligament (Fig 195)

This incision goes straight down to the external oblique aponeurosis which is the first landmark recognized when it is exposed the handle of the scalpel should be used to clear both the external ring and the aponeurosis upwards and downwards In making this incision the superficial epigastric vessels are divided and should be at once secured with pressure forceps These forceps should be held up by the assistant as they serve as excellent retractors Towards the end of the operation every one of these small arteries and vein should be tied with fine catgut In the great majority of cases the surgeon will incise the external oblique from one inguinal ring to the other but whether this be done or not the

are used to peel off the vessels without actually taking hold of them The left index finger introduced into the sac may facilitate the procedure though its introduction is rarely necessary The separation is effected transversely to the neck of the sac When once this is done, the constituents of the cord can be readily detached in an upward and downward direction by gauze dissection

If the hernia be of the congenital form the lower end of the sac must be divided above the upper pole of the testis, and it is inadvisable to close the lower segment in an attempt to reconstruct the tunica vaginalis, as a hydrocele is likely to develop The whole sac has now been freed up to the internal ring by blunt dissection the position of the ring being recognized by the deep epigastric artery and vein or by the appearance of a cuff of extra peritoneal fat around the neck of the sac The sac is now dealt with by one of the following methods

(a) The sac is ligatured twice as high as possible with catgut or thread

(b) In a few cases where the abdominal opening of the hernia is exceptionally wide it may be advisable to sew the peritoneum up with catgut instead of ligaturing or twisting the sac This applies to ventral as well as to ordinary inguinal herniæ

Methods of narrowing or obliterating the inguinal canal.—Three methods will be described —

1 Suturing the conjoined muscles to Poupart s ligament with replacement of the cord in the inguinal canal (Bassini s method)
2 Suturing the conjoined muscles to Poupart s ligament in front of the cord (Halstead s method)
3 Complete obliteration of the inguinal canal

In young children and adults in whom the inguinal canal has not been stretched by the frequent descent of a hernia—in other words those in whom the parts are normal but for the presence of a congenital pouch of peritoneum—it is only necessary to deal with the sac in the manner described

But in most cases where the radical cure is required it is

is usually met in reducing intestine In some exceptional cases of hernia of the cæcum or sigmoid flexure it may be necessary to dissect off adhesions to the posterior wall but any small intestine is readily returned and prevented from protruding during the further step by sponge pressure Occasionally the bladder projects into the hernial sac on its inner side, and special caution should be exercised lest it be opened in the course of the dissection—an accident which has happened in many cases

Much more frequently the omentum gives trouble owing to its adhesions or to its local hypertrophy In dealing with adherent omentum it is often best to disregard the lower adhesions and commence with the pedicle where they will probably be absent After ligature and division of this the omentum in the sac can be removed in one piece with the latter This method is still more useful in umbilical hernia It is essential that the omentum should be freed completely, and if necessary the protruding part is excised after securing its neck by several catgut ligatures This should be done slowly and carefully as in several instances death has followed the slipping of a ligature from the omental pedicle

It is further important that the ligatures should not be placed too close to the intestine Nor should they be too thick or lumpy thickening of the omental stump may occur

Fine catgut or silk securely knotted answers best and when the operator is satisfied that there is no bleeding from any vessel in the omental pedicle the latter is gently pushed up into the abdomen After its return it is a good pre caution to introduce a small sponge on a holder through the internal ring to make sure that there is no hæmorrhage

The sac is now isolated from the cord the higher up—i e the nearer to the internal ring—that this isolation is com menced the easier it is to effect The spermatic vessels and the vas deferens are as a rule spread out around the sac especially on its posterior aspect In congenital herniæ they may project into its interior covered by a fold of peritoneum Their separation is mainly accomplished with forceps, which

but unless a varicocele exists it is unnecessary (as sometimes advised) to excise any of the veins of the cord The cord is lifted up by two blunt hooks, which are held by an assistant and a series of interrupted sutures is passed through the lower edge of the muscles that go to form the conjoined tendon and through the inner edge of Poupart's ligament (Fig 190) It is most important that both conjoined tendon and Poupart's ligament are carefully freed of all fatty or areolar tissue before approximation as this tissue prevents firm union between them These sutures are introduced in a series before any one of them is tied They all lie beneath the cord, and care must be taken in passing the curved needle through Poupart's ligament that the external iliac vessels are not interfered with By securing these sutures the internal ring is narrowed and the possibility of a direct recurrence is reduced The cord is now replaced and the two edges of the cut external oblique are sewn together again over the cord The ilio inguinal nerve must be avoided Finally any subcutaneous vessels which have been held in pressure forceps are ligatured with fine catgut if necessary and the wound is closed in the ordinary manner with silkworm gut sutures, without drainage A sterilized dressing is applied with firm pressure whilst the thigh is kept somewhat flexed It is rarely necessary to remove the spica bandage until the tenth day, when the silkworm gut sutures are taken out and a pad and bandage re applied At the end of a fortnight to three weeks the patient may be allowed up but prior to this he will have breathing and leg exercises in bed No truss should be worn

The method just described is not applicable to all cases In some the conjoined tendon is poorly developed and in some it can only be fixed to Poupart's ligament with difficulty This implies subsequent tension and strain when the patient uses his abdominal muscles

2 *Method of suturing the conjoined muscles to Pourpart's ligament in front of the cord* —By the previously described method the surgeon narrows the upper opening of the inguinal canal to any desired degree but it is not suitable for all cases, owing to the difficulties of bringing down the internal oblique

advisable that the canal should be narrowed and considerable changes in the methods of doing this have been made during the last twenty years or so It is unnecessary to describe the host of modifications to which various surgeons names have been attached

1 *Method of suturing the conjoined muscles to Poupart's ligament behind the cord* (Bassini) --The aponeurosis of the external oblique is divided parallel to and above Poupart s ligament from the external ring to a point just above the internal ring The cord is thus exposed surrounded by the cremasteric fibres and the lower edge of the internal oblique muscle is clearly defined as it arches over the cord The latter is then lifted mainly by blunt dissection from its bed and at the same time the inner surface of the external oblique is defined and cleared both upwards and downwards so that the strong band which forms Poupart s ligament is thoroughly exposed The cremasteric layer is then opened so that the sac can be isolated and dealt with by one of the methods already described Any surrounding fat should be removed

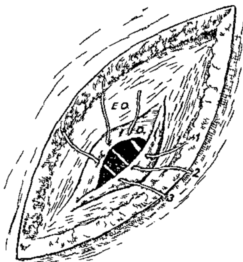


Fig 196-- Radical cure of inguinal hernia

The aponeurosis of the external oblique has been divided Three deep sutures (1 3) have been passed through the internal oblique (I O) the transversalis and Poupart s ligament E O External oblique The spermatic cord has been purposely omitted in this figure for the sake of clearness

surrounding it comes into view An opening is made into the sac and the forefinger is passed into it and thence into the the *peritoneal cavity to discover any adhesions* The finger is then passed downwards beneath the floor of the inguinal canal to ascertain if there is any weakness or bulging in this region By this procedure a direct hernia which would otherwise have been missed is often revealed Having made certain that the sac is empty the surgeon twists it so that its lumen is completely obliterated It is then transfixed at its base The floor of the inguinal canal is now carefully

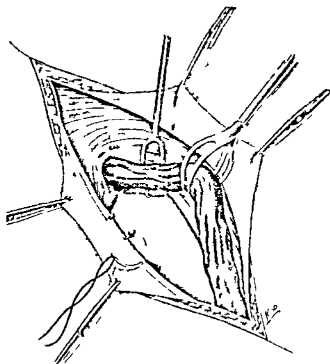


Fig 197 —Radical cure of right inguinal hernia After the sac has been transfixed and removed the fascia transversalis is attached to the deep aspect of Poupart s ligament

and transversalis muscles to Poupart s ligament without undue tension The method now to be described avoids this, it *consists in restoring the valvular action of these muscles* by giving them a lower attachment in front of the cord

It is assumed that the external oblique has been divided over the cord parallel to Poupart s ligament that the lower edge of the conjoined muscles where they arch over the cord has been thoroughly exposed and isolated and that the hernial sac has been dealt with in the manner described above The lower portion of the external oblique including the external pillar of the ring is now held up with forceps and a curved needle *carrying a strong piece of strong catgut or silk* according to choice is passed from without inwards through the external oblique just above Poupart s ligament The needle is then made to traverse the lower edge of the conjoined muscles from within—i e from their abdominal aspect—and back again a quarter of an inch nearer the middle line It is now passed through the external oblique the same distance from the original point of entrance

Thus the so called mattress suture is completed the needle is released and the two ends of the suture are held in a pressure forceps until ready for tying A second and even if thought advisable a third loop of suture are then introduced in the same way all of them passing in front of the cord which need not be raised from its normal position in the canal Two points must be attended to—the ilio inguinal nerve *must not* be included in any of the sutures (as is very apt to occur) and the suture *material must be perfectly aseptic* and not too thick

The sutures are now tied and the lower edge of the muscles is thus brought down in front of the cord It only remains to sew up the divided external oblique

Probably the best modification of the Bassini technique is the one I (C W) always employ The inguinal canal is *opened from end to end by incising the external oblique* muscle The sac is carefully dissected off from the anterior surface of the cord Subsequently the sac is pulled upon and as its neck becomes fully exposed the extraperitoneal fat

Radical Cure of Femoral Hernia

The operation which is most generally employed is that which was devised by Lotheissen. The incision extends over the lower half of the inguinal canal and then curves downwards at its inner end to pass superficially to the femoral canal and the saphenous opening. The femoral hernial sac which is usually surrounded by a considerable amount of fatty tissue is exposed as it emerges through the saphenous opening and by dividing the upper curved crescentic border of this opening the sac may be traced upwards as far as its exit through the femoral canal. It is opened in the usual way and the contents are carefully examined. If no contra indication exists the contents are returned to the abdomen and the fundus of the sac is temporarily closed with artery forceps.

The inguinal canal is now opened by incising the external oblique aponeurosis in the direction of its fibres exactly as for an inguinal hernia. The spermatic cord is drawn upwards out of the wound and the fascia transversalis on the floor of the canal torn through with forceps. It is then an easy matter to secure the neck of the femoral hernial sac from within at the point where it is passing through the femoral canal. A pair of artery forceps is applied to the neck of the sac in this situation and gentle traction is sufficient to draw the sac from the thigh backwards through the femoral canal into the inguinal canal where it is dealt with in a manner precisely similar to that which is employed for the radical cure of an inguinal hernia. It is usually considered advisable to close the femoral canal, and the simplest way of effecting this is to suture the lower border of the conjoined tendon to the fascia and periosteum covering the pubic bone (Cooper's ligament).

It may also be closed by a loose darn of thread or silk placed from the inguinal to the pectineal ligaments. Another method is to sew the torn lower edge of the fascia transversalis, where it is attached to the inguinal ligament, down to the pectineal fascia.

In this approach it is very important to repair the fascia transversalis again to restore the floor of the canal. Direct

inguinal hernia is not uncommon after the high femoral operation

The bladder may be associated with a hernial sac in the inguinal or femoral region the former being the more common (Fig 200)

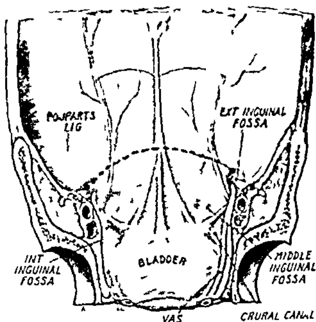


Fig 200 —Drawing of posterior surface of the anterior abdominal wall showing the relation of the bladder to the hernial orifices

RADICAL CURE OF FEMORAL HERNIA BY LOWER ROUTE

Incision —(1) A vertical incision 2 in by 3 in long is made centred over the femoral canal or (2) an incision is made down to the external oblique aponeurosis as in the Lothiessen operation *The lower skin flap is then undercut to give an* adequate exposure of the saphenous opening

Procedure —The hernial sac is defined opened and its

contents inspected and reduced With a finger within the opened sac the latter is cleared by gauze dissection as high as possible Slight traction is applied the neck of the sac is transfixed with catgut and ligatured Redundant sac is cut away and the stump retracts up into the abdomen when released The wound is then closed

This lower operation gives results as good as the upper operation but reduction is not always possible from below There is no danger of later development of a direct inguinal hernia after the lower operation This does occur not infrequently after the upper operation

McEvedy's Approach to Femoral Hernia

The two operations described above give a very limited view of the femoral canal McEvedy's approach is via a 3 inch vertical incision ending below over the femoral canal The sac is exposed in the lower part of the incision and higher up the inguinal ligament and rectus sheath are seen The rectus sheath is opened in its lower part by an oblique incision ending 1 inch above the external ring The rectus muscle may have to be retracted inwards The fascia transversalis is opened vertically and the extraperitoneal plane opened up The hernial sac is seen as a funnel shaped structure entering the femoral canal If small the sac can be drawn up opened and excised If large it may be opened below the contents reduced and then drawn up If strangulated it may be opened above and below

The advantage of this method is the surprising exposure The great disadvantage is the damage inflicted on the abdominal wall It is a useful method for very large or recurrent herniæ and in strangulation

A K Henry's approach is similar but the extraperitoneal plane is found through the rectus muscles as in exposing the bladder It is useful in dealing with bilateral herniæ when a transverse skin incision may be used with advantage

CHAPTER II

OPERATIONS FOR STRANGULATED HERNIA

Special instruments required —A hernia knife fine toothed forceps blunt-pointed bistoury a hernia director blunt hooks As it may possibly be necessary to resect a portion of the prolapsed intestine clamps intestinal needles, and suitable sutures should be at hand

The hernia knife should be as simple as possible and should have a short cutting edge

The following description applies especially to inguinal and femoral herniæ

1 **Exposure and opening of the sac** —An incision is made over the neck of the sac, and as a rule in the long axis of the tumour This incision should be placed as far from the genital region as possible thus in the case of inguinal hernia it should not encroach on the scrotum The various layers between the integument and the sac are divided by clean and precise cuts that involve the whole length of the incision Any vessels that are liable to division are secured with pressure forceps

There is no need to use a director in dividing the tissues which cover the sac and that dangerous instrument can very well at this stage be dispensed with

It is needless to say that the various precise anatomical coverings of the sac cannot be identified as they are divided The subcutaneous tissue can of course be recognized and in the inguinal region the cremasteric fascia can always be made out but beyond this the surgeon will be but little reminded of the coverings which are so elaborately displayed in the dissecting room

The sac when well exposed, has usually a distinct capsule like outline Its wall is tense and if it is thin the blood stained fluid contained therein or the purple gut, may give to the structure a bluish aspect In a thick walled sac this somewhat characteristic bluish tint may be entirely absent

The sac is best identified by the fingers rather than by the eyes As the hernia is laid bare the surgeon should from time to time pinch up the coverings yet left undivided between the finger and thumb, and estimate their thickness

Any attempt to demonstrate the sac by counting the supposed anatomical layers that are divided in exposing it is almost sure to be fallacious

The sac having been identified is well exposed and its neck is well cleared

The sac wall is then picked up by the fine toothed forceps and opened by means of a scalpel the blade of which is held nearly flat The operator pulls the little fold of sac away from the bowel as he makes the division When once an opening is made it is readily enlarged by means of a blunt pointed bistoury or blunt pointed scissors. The sac should be cleanly opened and not torn open The operation up to this point should be carried out by careful incisions and not by tearing In most cases opening the sac is immediately followed by the escape of some blood stained fluid Occasionally œdema accounts for the presence of some fluid *outside* the sac

2 **Division of the stricture and treatment of the contents of the sac** —The exposed bowel is carefully examined and its treatment determined upon The less it is handled the better If it be in a condition suitable for reduction the next step will be to divide the stricture The neck of the sac is examined with the point of the left forefinger and the density of the stricture and the best point for introducing the hernia knife are determined The finger must be used gently There must be no attempt to dilate the stricture with the finger The part of the bowel that usually suffers most in strangulated hernia is the part directly embraced by the stricture and this is the

part that will be crushed and bruised if persistent attempts be made to force the finger into the stricture.

The forefinger lies with the nail towards the bowel and the most the surgeon does is to make clear a point at which the hernia knife can be inserted. The finger is the best director; the hernia knife is passed along it with the blade flat against the finger. The point of the knife at last reaches the pulp of the finger that is pressed against the stricture, while the nail lies against the bowel. The point of the knife is passed still on the flat, beyond the finger and into the ring. It is then turned with its edge towards the stricture, and by a slight movement of the blade the stricture is divided.

The left forefinger or in a case of a tight neck to the sac the little finger, acts throughout as a guide. It is retained in position after the knife has been withdrawn, and is then employed to ascertain that the division of the stricture has been sufficiently complete.

In some instances, especially femoral, the finger cannot be entirely relied upon and a broad flat director must be used.

It is introduced with the right hand, guided by the left forefinger, and must be most carefully manipulated. The left forefinger and the director are employed in exactly the same manner and relation as the forefinger and the knife.

When once the director has been passed through the stricture and is in place, it is held in position with the left hand while the hernia knife is used in the right.

The knife must be cautiously introduced. It is possible for the bowel to overlap the director and the knife and to be cut by the movement of the blade. When the bowel is in danger it should be pressed aside by the assistant with his finger, or with a small sponge held in a holder. The knife should have but a very limited cutting edge and it should be seen that the cutting edge is well within the stricture before the division is attempted.

After the knife has been withdrawn, the stricture may

be further dilated with the director which is forced against the divided fibres, and therefore away from the bowel.

It should be a rule to endeavour to make as slight a division of the stricture as possible—such a division as will allow of the gut being reduced, and no more

The loop of bowel should now be gently drawn down and the constricted part examined, since it is here that the injurious effects of the strangulation may be most manifest.

The next step is to reduce the gut the fibrous and muscular structures around the hernial orifice being relaxed as far as possible In inguinal and femoral ruptures this is effected by flexing the thigh upon the pelvis An attempt is then made to squeeze the bowel by a kind of kneading movement with the thumb and fingers through the opening

The manipulation must be of the gentlest, and the surgeon must be prepared to exercise considerable patience If the coil will not return by pressure applied at one extremity it may yield to pressure applied at the other end of the loop

In some cases of difficulty the reduction is rendered easier if the margin of the hernial orifice is held up by means of a small blunt hook introduced into it or by two pressure forceps grasping the opened sac and straightening its neck. This especially applies to large inguinal herniæ

In other cases more bowel may be drawn down from the abdomen and the reduction may then be directed in the line in which the withdrawal of the intestine appears to be the more easily effected If the bowel be much distended that part nearest to the ring can often be emptied of some portion of its contents by judicious manipulation

After the reduction the finger should be passed through the ring into the abdomen to make sure that all is clear The sac is now swabbed dry

If any omentum exists in the hernia it must be dealt with as its condition demands If it appears healthy is small in amount and is quite free from adhesions it may be reduced Nothing better can be done for it In the majority of cases however it will need to be removed It will be found to be

altered in structure, to be inflamed, or to be matted into a granular kind of mass or to be adherent

Small portions may be ligatured *en masse* with one catgut ligature and then cut off. Larger portions are most conveniently dealt with by passing a series of loops of catgut by means of an aneurysm needle each loop enclosing one or more omental vessels Fine catgut may be used, but each loop must be securely knotted a treble knot being the safest When the expanded portion of the omentum has been excised below the ligatures the latter should be inspected and cut short before returning the stump into the abdomen The risk of a ligature slipping is avoided by making each include only a small part of the omental neck

It is well to remember that however large the protruded mass may be it will have a comparatively slender neck

The reduction of the stump of the omentum should be in every case complete It should be returned quite free into the abdomen. No part should be left either in the sac or in its neck.

3 **Treatment of the sac and closure of the wound** —In nearly all cases the operation can be completed by performing a radical cure The sac is rapidly cleared its neck isolated and firmly ligated and the inguinal or femoral canal (as the case may be) narrowed by the methods already described The wound should be rendered as aseptic as possible before it is closed and in some cases it is advisable to retain a drainage tube in it for a few days

4 **Treatment of complications** i *When the intestine is adherent to the sac* —Adhesions of bowel to omentum are readily enough dealt with The omentum if it cannot be peeled off from the intestine is cut away with scissors until only the slightest trace of it is left still attached to the gut which can then be reduced

Adhesions of the bowel to the sac may when slight and recent be broken down with the finger or a flat director when however they are of old standing and extensive their treatment becomes a matter of some difficulty These examples of extensive and firm adhesions are for the most

part met with in old umbilical or scrotal herniæ of large size which have been for many years irreducible and have perhaps been more than once inflamed

The breaking down of such adhesions must be a matter of infinite care, as the bowel is as a rule, more readily torn than is the wall of the sac

Many of the adhesions can be divided with scissors or a scalpel and some may be torn through after partial division

II *When the gut is gangrenous* —Much has been written upon the subject of the treatment of gangrenous intestine in hernia and very remarkable differences of opinion have been expressed upon the question It would be out of place to enter into a discussion of this subject or to consider minutely the physical signs that may distinguish intestine which is gangrenous from that which may still recover

If the bowel when exposed be in what may be termed a doubtful condition it should be retained outside the abdomen the stricture having been relieved if it recovers it can be returned if it dies resection can be carried out with the patient in a better condition

If the bowel when exposed be found to be gangrenous three courses are open to the operator

(*a*) If the area of intestine threatening to perforate or become gangrenous be quite small it may be invaginated by a series of Lembert s sutures and the gut returned This is the simplest method though it is not of course suitable to cases of much damaged intestine It must be noted, moreover that adhesions are almost certain to form round the repaired portion after its return

(*b*) The damaged gut is resected and the two portions are united either by the end to end or the side to side method It is essential to divide the intestine where it is comparatively healthy i e many inches may have to be removed Hence it is rarely practicable to perform the resection within the hernial sac and we advise a separate laparotomy wound (paramedian) and that the damaged loop should be drawn up from the hernia after division of the stricture and so out

of the abdomen on to warm moist pads In its transit, soiling of the peritoneum is easily prevented by the use of swabs or sponges, or by enclosing the loop in a sterile rubber glove

For the details of resection see p 333 Whether end to-end or side to side union should be employed is perhaps doubtful the former is more quickly done and appears to give the better results (unless the proximal portion is much dilated) In either case it is essential to remove enough intestine for the resection to be done through fairly normal tissues The only reliable guide to the site for safe resection is the presence of pulsation in the mesenteric vessels

(c) The gangrenous loop may be left in the sac after it has been incised and a small sized Paul s glass tube tied in it The tube is continuous with a thin rubber one which drains the fæculent contents into a suitable receiver The hope is that after a week or two it may be possible to carry out a second operation of resection

This method is really a counsel of despair and is very rarely justified as the mortality attending it is so high

iii *When the intestine is wounded* —The bowel may be accidentally wounded when too rash a division of the superficial parts is made when adhesions exist between the gut and the sac when the altered gut is mistaken for the sac or when the loop of bowel comes into accidental contact with the edge of the hernia knife as it is being passed through the stricture

The opening made should in each case be closed by means of two rows of fine catgut sutures the first including all the coats the second a Lembert s suture taking up only the outer ones The loop of gut should be returned into the abdomen and if the wound has been extensive it will be as well to leave the sac open and to introduce a drainage tube in case the intestine should give way later

Umbilical hernia —In addition to the instruments already enumerated the surgeon should be provided with spatulæ and large curved needles

The patient is prepared as for an abdominal section (p 316) and the general disposition of those concerned in the operation

should be the same as is observed in that procedure The surgeon will always stand to the patient s right

Nearly the whole of the skin involved in the protrusion is now marked off by means of an elliptical incision which includes all the thin skin over the hernial protrusion

The first incision is only skin deep and the hernia must be moved from one side to the other with the left hand as occasion requires

The surgeon now deepens the wound on one side of the base of the mass and by cutting through the subcutaneous tissue aims at exposing the aponeurosis of the abdomen a little way beyond—i e to one side of the neck of the rupture To effect this such skin as covers the base of the protrusion is turned back When once the aponeurosis is reached it is followed all round the stalk of the tumour by deepening the incision When this has been done the hernia covered by perfectly undisturbed skin will be entirely isolated from all the tissues outside the abdomen and will be attached only by its neck The neck must be well cleared and the aponeurosis which bounds it and which therefore forms the margin of the hernial orifice must be laid quite bare

The sac may now be opened at any convenient spot where it can be proved to be free from adhesions to its contents This condition will be found to be present near the opening in the abdominal wall rather than on the convexity of the hernia It is always best therefore to open the sac first at its neck and work all round the latter The contents are exposed and are dealt with in the manner already described Adhesions are divided the bowel is freed and if in sound condition is reduced into the abdomen Before this can be done the hernial orifice will need to be divided and this can be effected by enlarging the opening above and below the neck of the sac in the median line with a probe pointed bistoury This division may be extraperitoneal After the gut has been replaced the omentum is excised or dealt with in a manner suited to its condition

The omentum is best ligatured and cut through where it emerges from the abdomen without regard to its adhesion

to the sac By this method considerable time is saved in the operation

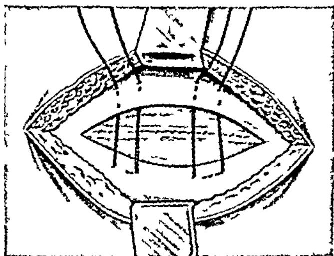
The sac is at last emptied and the hole leading into the abdomen is then plugged with a swab or sponge secured in a holder

The next step is to remove the whole of the sac and its coverings including the elliptical portion of the skin down to the level of the aponeurosis This is effected by completing the annular incision round the neck of the sac

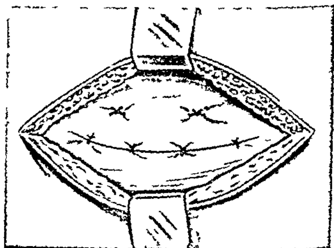
The margins of the ring are now freshened as in plastic operations involving the skin and the opening in the aponeurotic part of the abdominal parietes is closed by sutures These buried sutures should be of strong catgut They may be introduced on a curved needle in a needle holder Before they are inserted the sponge should be removed and be replaced by the end of a spatula which will serve to protect the intestines from injury As many sutures as possible should be introduced before any are tied They must be closely placed—four to six to the inch—and must include the whole thickness of the aponeurosis and the peritoneum

C Mayo of Rochester U S A pointed out that the tension of the parts round the umbilical aperture is greater in the transverse than the vertical direction and introduced a method (which has been widely adopted) which includes a transverse elliptical incision of skin and fascia The neck of the sac is cut through its contents are returned into the abdomen and the peritoneal aperture is sewn up with catgut By means of two lateral incisions starting from the ring and crossing over the fibres of the recti muscles and by blunt dissection beneath its sheath two flaps of the aponeurosis are raised The lower one is drawn under the upper and secured by a number of interrupted sutures The upper flap is then drawn down in front of the first and also sutured (*see* Fig 201)

Ventral hernia (*radical cure*) —Ventral hernia is even more frequent than true umbilical the protrusion is



A



B

Fig 201 —Mayo s operation for umbilical hernia

A The peritoneal layer i lo e l a l mattress sutures ha e been inserte l to produce horizont l o erla p n of t e rectus sheath.

B The mattress sutures are tied (seen above) and the overlap is secured with interrupted sutures

often found in the right iliac region, resulting from a previous drainage of an appendicular abscess, etc The following applies to such a case

An elliptical or lozenge shaped incision is made so as to circumscribe all scar tissue and thinned skin—it is not in this layer that subsequent difficulty will be found in bringing together Careful dissection outside the sac is carried all round until the external oblique and its orifice are made out

The edge is raised and well undermined with the blunt dissector, the muscles below are then treated in the same way (it is rarely practicable to separate internal oblique and transversalis, one layer is made of the two) The sac has probably already been opened, in either case it is incised at some point where intestine and omentum are not adherent, and then the adhesions are separated and the contents returned These few words represent what may well be a delicate and tedious dissection involving ligature and removal of omentum, excision of an adherent vermiform appendix sometimes repair of wounded intestine, examination of the broad ligament and its contents in the female, etc Short-circuiting of intestine has been necessary sometimes complete excision of a portion with end to end suture occasionally

(1) Suppose the contents returned—the edges of the opening held up well by blunt hooks or Wells's forceps—and the peritoneum and transversalis fascia carefully sutured—in one layer—by a continuous suture of fine chromic catgut In passing this suture it may be a help to hold back intestine etc by a small gauze pad held by forceps withdrawing both as the suture line is completed

(2) Two layers should if possible, be obtained for suture outside the transversalis fascia the two deep muscles together forming one the external oblique aponeurosis the other Both must be repaired by interrupted catgut sutures (some use fine silk) the stitches placed very near together, and the *suture line not corresponding in direction in the two layers* This is as a rule easily managed by means of traction with blunt hooks

(3) Sometimes only two layers with which to close the orifice can be made sometimes only one In this case, overlapping flaps may well be employed

The Mayos and others warmly advocate overlapping the oblique aponeurosis at least, in all cases but it may be

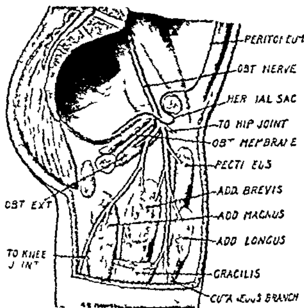


Fig 202 - Diagram showing relation of obturator hernia to the obturator nerve

doubted whether this is advisable or practicable After well undermining the aponeurosis edges they should be drawn over one another to see whether they overlap fairly easily it is not wise to make them overlap by extreme traction on the sutures—for obvious reasons. A moment's thought will show that the method described will make a firmer scar and involve less tension on the sutures than extensive overlapping

In the *after treatment* note especially the importance of

laxatives, thorough rest for several weeks before resumption of work, and the use of a surgical belt or other form of light support for many months, if not permanently

Obturator Hernia

This consists in a protrusion of small intestine through the upper part of the thyroid foramen and has usually been

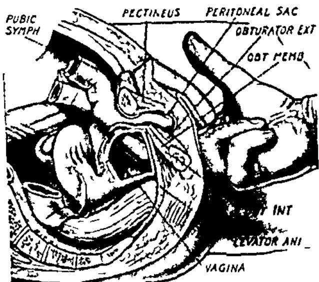


Fig 203 —Obturator hernia showing how a vaginal examination may lead to a correct diagnosis

observed in elderly females Multiple pregnancy is an important factor in its causation owing to the relaxed condition of the peritoneum It is not often recognized in the living except when strangulated and even then it is more likely to be discovered from the abdominal aspect during a laparotomy for acute obstruction than diagnosed apart from operation In some cases however it has been noted that in addition to the general signs of strangulation there was a

sense of deep resistance and of fullness close to the origin of the adductor muscles and that pain was referred down the obturator nerve to the inner side of the knee (Fig 20?) Rectal or vaginal examination may throw some light on the nature of the case (Fig 203) Treatment is generally confined to cases of strangulation and in these a laparotomy with the patient in the Trendelenburg position gives good exposure of the hernia It may be necessary in some cases to cut the fibrous ring at the upper part of the obturator membrane

PART X.—OPERATIONS ON THE URETHRA

OPERATIVE TREATMENT OF STRICTURE OF THE URETHRA

OPERATIONS which involve an incision, namely internal and external urethrotomy, are required only in a small proportion of the cases of stricture. In the great majority gradual (intermittent) dilatation with bougies will suffice. Only when this fails from impermeability, from extreme resiliency of the stricture, or from irritability of the urethra, is a cutting operation advisable. Moreover, urethrotomy must always be followed by the use of bougies. A few brief notes on **intermittent dilatation** will therefore be in place here.

1. The safest form of bougie to employ is the flexible one, made with the proximal half stiffer than the distal one for convenience of manipulation. Bougies should be graduated according to the French scale, i.e. in millimetres of circumference round their largest portion. No. 12 English corresponds roughly in size to No. 20 French. Full dilatation of the urethra allows the passage of No. 25 French; it is never necessary to go beyond this and sometimes advisable to be content with a lower maximum.

In skilled hands, especially if the patient is under an anæsthetic, Lister's metal 'sounds' are very useful; but all such rigid bougies—and especially the small sizes—are dangerous from the risk of causing false passages.

2. Before a course of dilatation is instituted the patient's urine should be carefully examined, to determine the amount passed in the twenty-four hours, the presence of albumin

or pus etc Abstinence from alcohol should be insisted on during the treatment and it is well to give urotropine in moderate doeses

3 The pain usually involved by the passage of bougies may be much lessened by the preliminary filling of the urethra with a 0 1% solution of amethocaine or 1% solution of Xylocaine this solution to be held in for ten minutes The most scrupulous care must be taken as to aseptic precautions and if the surface of a bougie is found to be cracked or rough it should at once be discarded A good lubricant is essential

4 Progress to be safe must be slow in the case of a tight stricture For instance at the first sitting dilatation up to No 8 French is attained this sized bougie being tightly gripped It should be left in for twenty minutes or so, and then the urethra is given a rest for a few days recommencing with No 6 or 7 and going on to the largest size that will pass without undue force It is important not to cause material pain or bleeding and to avoid the risk of rigors

No 25 should be aimed at ultimately and for a long time the patient should be examined to make sure the stricture does not contract again

There is no doubt that some cases of organic stricture are cured by gradual dilatation just as happens sometimes after internal or external urethrotomy but in most cases it is not safe to omit the regular passage of bougies

Gradual dilatation outlined above will not succeed in all cases If the stricture is so tight that no bougie can be introduced or so resilient that no progress beyond a certain point can be made the surgeon has the choice between two operations—internal and external urethrotomy The patient s recovery after the former is so much more speedy that in our opinion it should always be preferred external urethrotomy being reserved for the very few cases in which repeated trial under an anæsthetic fails to pass the smallest guide bougie through the stricture

I INTERNAL URETHROTOMY

The operation consists in cutting through the stricture by

means of a guarded knife (urethrotome) introduced along the urethra A great variety of urethrotomes has been devised Thomson Walker's, a modification of Maisonneuve's is probably the best (Fig 204) It consists of a fine curved metal staff which has a deep groove on the concave surface extending from the perineal end to just beyond the commencement of the curve At the point of the staff is a male screw on which a small bulbous tip fits This tip may be removed and a fine flexible guide screwed on to the end of the staff by means of a metal end with a female screw This metal end is tapered and projects a short distance inside the flexible guide which thus expands gradually to the thickness of the staff A triangular knife is fixed to one end of a fine steel rod the other end terminates in a metal button on which is the number representing the size in French gauge to which the knife cuts The apex of the triangular knife is blunt smooth and broad so that it can glide along the mucous membrane without cutting it The anterior and posterior edges of the triangle are sharp A small flange on each side of the base of the triangle runs under the lips of the deep groove in the staff and prevents the knife from slipping up Two large flat trans

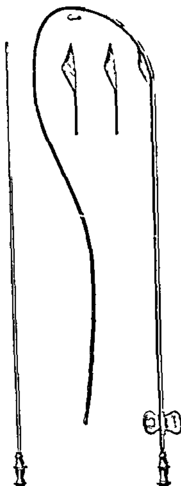


Fig 204 — Thomson Walker's urethrotome

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I INTERNAL URETHROTOMY

The operation consists in cutting through the stricture by

the staff (Fig 205) The glans penis is raised by the left fingers and thumb, the knife is slipped past the meatus and pushed steadily along the urethra until the resistance of the stricture is felt A sharp push cuts the stricture, and the knife slips on and cuts any others that may be present Unless the knife be boldly pushed through *the stricture the fibrous* tissue will not be cut The knife rod is withdrawn altogether, and the staff and guide are removed

A large steel sound (12-11 size) is passed to see that the stricture has been completely divided The sound is withdrawn and a coudé catheter tied in

After the operation the patient need only remain in bed a few days The object of the retained catheter is to prevent the wound in the urethra from becoming soiled with the urine, which is usually infected

II EXTERNAL URETHROTOMY (WHEELHOUSE'S OPERATION)

In former editions the form of external urethrotomy which is performed with the aid of Syme's grooved staff was described But when the latter instrument can be introduced it is always easy to pass a fine bougie, and there-

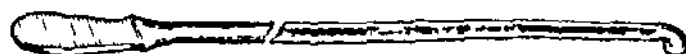


Fig 206 —Staff for Wheelhouse's operation

fore to do an internal urethrotomy, thus saving the patient a perineal wound and the risk of a fistula In our opinion Syme's staff should become obsolete

Instruments required for Wheelhouse's operation —Manacles or Clover's crutch Wheelhouse's hooked staff (Fig 206) two pairs of fine ribbed forceps, scalpels, catheters probe, probe pointed director Teale's probe gorget curved needles needle holder sponges in holders

Operation —The patient is placed in the lithotomy position The staff is to be introduced with the groove looking towards the surface and brought gently into contact with the stricture Whilst an assistant holds the staff in this position an incision is

verse wings are fixed on each side near the proximal end of the staff and provide a good grip for the fingers and thumb of the assistant *A steel rod which fits into the groove in the staff* serves to stiffen it during the introduction of the instrument and is useful in cleaning the groove The rod is removed for the insertion of the knife

Operation —Spinal or local anæsthesia may be used but

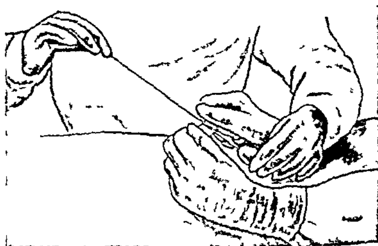


Fig 205 —Internal urethrotomy
Hands of assistant holding wings of urethrotome surgeon steadying penis and pushing triangular knife along guide

a general anæsthetic is preferable The surgeon stands to the right of the patient The filiform guide is introduced through the stricture the fine staff screwed on to the guide and the instrument well oiled is pushed along the urethra The staff lies with the curve in the membranous and prostatic segments of the urethra while the flexible guide lies coiled up inside the bladder

The staff is held by an assistant at an angle of 45 the *instrument should be kept absolutely steady* The triangular knife is dipped in sterile oil and introduced into the groove of

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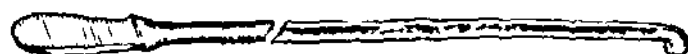


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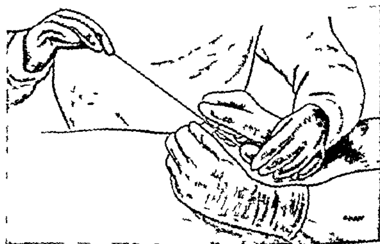


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and held apart.* The staff is then gently withdrawn until the button point appears in the wound. It is now turned round so that the point hooks on to the front edge of the urethral wound which is thus "stretched open at three points, and the operator looks into it immediately in front of the stricture (Fig. 207). While thus held open, a probe pointed director is inserted into the urethra, and the operator, if he cannot see the opening of the stricture—which is often possible—generally succeeds in very quickly finding it and passes the point onwards through the stricture towards the bladder. The stricture is sometimes hidden amongst a crop of granulations or warty growths in the midst of which the probe point easily finds the true passage. The director having been passed into the bladder (its entrance into which is clearly demonstrated by the freedom of its movements), its groove is turned downwards, the whole length of the stricture is carefully and deliberately divided on its under surface, and the passage is thus cleared. The director is still held in the same position, and a straight probe pointed bistoury is run along the groove to ensure complete division of all bands or other obstructions. These being thoroughly cleared, the old difficulty of directing the point of a catheter through the divided stricture and onwards into the bladder is to be overcome.

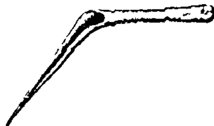


Fig. 208.—Teale's probe gorget.

To effect this, the point of a Teale's probe gorget (Fig. 208) is introduced into the groove on the director, and, guided by it, is passed onwards into the bladder, dilating the divided stricture and forming a metallic floor along which the point of the catheter cannot fail to pass securely into the bladder. The entry of the gorget into the latter viscus is signalized by an immediate gush of urine along it. A silver catheter (No. 10 or 11) is now passed from the meatus down into the wound, is made to pass once or twice through the divided urethra, where it can be seen in the wound, to render certain the fact that no obstructing bands have been left undivided, and is then guided by the probe dilator, passed easily and

* It is perhaps better not to trust to the insecure hold of these forceps, but to retract the urethral edges by means of two suture loops introduced by curved needles.

made in the middle line of the perineum The tissues of the perineum are to be steadily divided until the urethra is reached This is now to be opened in the groove of the staff not upon its point

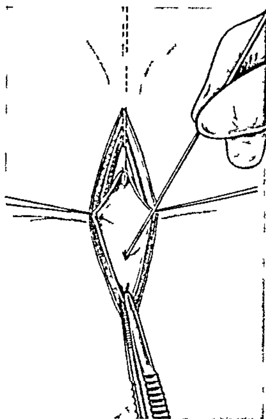


Fig 207 —Wheelhouse s operation for urethral stricture

so as certainly to secure a quarter of an inch of healthy tube immediately in front of the stricture As soon as the urethra is opened and the groove in the staff fully exposed the edges of the healthy urethra are to be seized on each side with straight bladed ribbed forceps

PART XI—OPERATIONS ON THE SCROTUM AND PENIS

CHAPTER I

OPERATIVE TREATMENT OF HYDROCELE AND SPERMATOCELE

General Considerations The best incision to use for these swellings is one directly into the scrotum It should be noted that in large scrotal swellings *the penile skin becomes* absorbed into the scrotum and due regard to this fact must be made in making the incision else the resulting scar will extend onto the shaft of the penis (Fig 209) It is quite



Fig 209 —Diagrams to show correct and incorrect incisions for large scrotal hydrocele

(a) Correct incision (b) Incision too high and (c) showing how if the incision is too high the scar will pass on to the body of the penis

easy to sterilize the skin prior to operation since the rugae are stretched out The incision should be made through all layers until the thin wall of the spermatocele or hydrocele is reached Dissection should then be made in this plane

The question of drainage after operation requires comment The tube is difficult to place through the many scrotal layers

certainly along the posterior part of the urethra into the bladder The gorget is now withdrawn the catheter fastened in the urethra and allowed to remain for three or four days an elastic tube conveying the urine away After three or four days the catheter is removed and is then passed daily or every second or third day according to circumstances, until the wound in the perineum is healed and after the parts have become consolidated it requires of course to be passed still from time to time, to prevent recontraction — *Wheelhouse.*

The operation requires good light and infinite patience There is usually much difficulty in detecting the orifice of the stricture and matters may be complicated by a false passage The originator s account has been retained because this operation is still performed and frequently asked about in examinations But its difficulties and drawbacks are, we think made too light of in the above account The operation has sometimes completely failed in the hands of the best surgeons owing to the difficulty in finding the proximal orifice of the urethra Rutherford Morison recommends in such cases that the bladder should be opened above the pubes a metal bougie introduced through this opening and its point made to impinge behind the stricture in the perineum thus enabling the surgeon to cut through the stricture He records several successful cases

cut edge of the tunica vaginalis and the tissues immediately covering it If this suture (knotted at every few insertions) is applied the risk of subsequent hæmatoma is removed

The testis is now returned within the scrotum and the wound sewn up, a small drainage tube is inserted at the lower angle of the wound to be removed twenty four hours later The sutures should be of fine silkworm gut and should be placed close to the edges of the wound

Some operators (Jaboulay) have advocated inversion (i e turning the sac of the hydrocele inside out) instead of excision of the parietal layer The sac is slit open vertically the two sides turned back and secured together behind the testis This is a very inferior method to excision of the parietal layer and is wholly unsuited to large or thick walled hydroceles

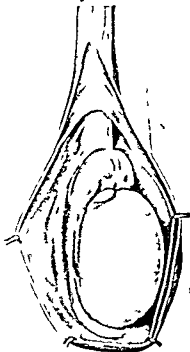


Fig 210 —Normal relation of tunica vaginalis to testis and cord showing amount of serous coat to be excised in radical operation for hydrocele

The excision of a *hydrocele of the cord* presents no difficulty as after making a short incision over the cyst it can be separated from the constituents of the cord and removed entire

Operative Treatment of Spermatocele

A scrotal incision is made over the swelling and deepened until the very thin cyst wall is reached Careful dissection is made in this plane and the thin walled cyst often loculated can be shelled out entirely Its small attachment to the epididymis may have to be ligated Drainage is usually unnecessary

and is near the perineum, thus inviting infection The post-operative swelling of the scrotum is often due to œdema and hæmatoma of the scrotal integuments and not from hæmatoma around the testes Because of this many surgeons omit drainage of the wound but control the post operative swelling with a firm support

The suture material for the scrotal skin should be mentioned Post-operative œdema and the presence of rugæ tend to cause silk to be buried and difficult to remove Stout nylon or silk worm gut or nickel clips should be used

Operative Treatment of Hydrocele

Excision of the parietal part of the sac—This operation is the most certain to lead to a cure of the hydrocele and conforms to the modern principles of surgery The method is especially adapted for hydroceles of the tunica vaginalis in adults Hydroceles of the cord are also best treated by excision though in this case the entire sac is removed whereas in hydrocele of the tunica vaginalis only the parietal portion is excised

An incision about 3 inches long is made over the long axis of the hydrocele at its upper part and is carried down through the cremasteric layer With forceps the tissues immediately covering the sac are peeled off on either side whilst the hydrocele is pushed out of the wound as far as practicable It is convenient not to open the sac until it has been well laid bare on either side A puncture is then made and the fluid evacuated the sac is laid freely open with scissors and then cut away Care must be taken in doing this *to keep outside the epididymis externally and not to injure the vessels of the cord or the vas deferens internally* It should be remembered that in old hydroceles the body of the epididymis is often displaced from the testis by a pouch Fig 210 shows the relation of the upper part of the sac to the cord etc and indicates how much may safely be cut away Rough handling of the testis must be avoided

As secondary oozing is very apt to occur it is a good plan *to run a catgut continuous suture (hæmostatic) round the*

the tissues between the skin and the tunica vaginalis the soft parts should be gently moved to and fro by the left hand which still keeps its position on the scrotum *The mobility* of the superficial layers is striking but the tunica as it is approached is recognized by its perfect immobility

When the skin is involved this means of noting the progressive depths of the incision is lost

The tunica vaginalis is opened and the testis and epididymis are inspected Frequently an accurate diagnosis is not possible until this moment

In exposing the tumour, care should be taken not to cut into it The operation is complicated by opening an abscess cavity or a cyst, or by cutting into a mass of soft growth

The cord is now thoroughly isolated with the fingers and secured by a clamp The assistant holds the clamp and the surgeon, grasping the testicle divides the cord with the knife about three quarters of an inch below the clamp The vessels of the cord are now secured It is impossible to distinguish the arteries from the veins Both veins and arteries are picked up with artery forceps and secured with catgut The two sets of veins should be tied separately Three or four ligatures may be required seldom more The vas deferens is included in one of them as a rule They should be knotted securely before the clamp is relaxed and should be left long until it is seen that all the vessels have been well tied Now relax the clamp and make certain that every divided vessel is secured before cutting the ligatures short and allowing the stump of the cord to retract

Any bleeding points in the scrotal incision must be secured

In applying the sutures either straight or curved needles may be used, threaded with fine silkworm gut In order to obtain an even line of union the edges of the incision should be stretched between two blunt hooks inserted at the extremities of the wound and held by the assistant This will prevent the in turning of the edges of the incision due to the contraction of the dartos and will allow of accurate adjustment of the parts It is well to introduce all the sutures before tying the first one A drainage tube may be secured

CHAPTER II

EXCISION OF THE TESTIS

This operation is performed chiefly on account of advanced tuberculous disease for new growth of the testis or for torsion of the testis

A clamp is the only special instrument required its blades should be protected by rubber to lessen the crushing of the vessels of the cord

Operation—The pubes must be shaved and the hair removed from the scrotum as far as possible The scrotum groin and perineum should have been previously washed repeatedly and antiseptic measures adopted (with caution as to the scrotal skin which is easily made sore by too strong lotions) An efficient and simple method of rendering the skin antiseptic is to paint it immediately before the operation with a solution of iodine 1 part to alcohol 40 parts

The testicle may rest upon a large gauze swab or a sponge placed between the thighs The immediate field of operation is surrounded by sterilized towels The best incision to employ is one over the lower part of the inguinal canal extending if necessary slightly downwards towards the neck of the scrotum The testis unless fixed to the scrotal wall by growth or sinuses is easily pushed upwards into the wound

When the skin is involved by the growth or when it has become adherent to the testis or is the seat of sinuses an elliptical incision that clears the affected skin and meets above and below should be made The position of these elliptical cuts must obviously depend upon the position of the implicated skin and they may have to be made upon the lateral or even the posterior aspects of the scrotum In dividing

CHAPTER III

OPERATIONS ON THE PENIS

I Circumcision

This operation is indicated in children with phimosis as its performance will prevent various troubles in later life The risk of venereal disease is lessened by circumcision as also of balanitis from retained secretion under the long prepuce Epithelioma of the penis moreover, is practically unknown among the circumcised

If done in early childhood it may fairly rank as a minor operation but in adults it is a more serious procedure as quick healing is more difficult to obtain

Even in children, poor results are not very infrequent, chiefly from failure to observe two points (1) to remove only the right amount of skin, and (2) to secure control of bleeding vessels especially those of the frænum Troublesome ulceration along the suture line and recurrent hæmorrhage are the respective dangers

Whether in children or in adults, a general anæsthetic should always be given, local anæsthesia is wholly un satisfactory for this operation

Instruments.—Four pairs of fine artery forceps a pair of straight sharp pointed scissors fine straight needles threaded with 00 catgut

Operation—The prepuce and glans are carefully cleaned with saline and the prepuce is fully retracted until the corona of the glans is completely exposed and all secretions which have accumulated behind it have been swabbed away In order to do this it may be necessary to stretch the opening in the prepuce before retraction becomes possible This is

by means of the last suture, and a large dressing of moistened sterile gauze firmly applied under a spica bandage

Comment—When this operation is done for advanced gummatous disease it is unnecessary to open the inguinal canal if for tuberculous disease, the higher the vas is divided the better, and the same applies to new growth In the last named the operation was sometimes extended upwards into the abdomen and an attempt made to remove in one sheet of tissue the testis the contents of the inguinal canal the iliac and psoas fascia and the glands lying alongside the aorta This formidable procedure is unnecessary and the patient is better served by radio therapy to the abdominal glands and inguinal region In tuberculous disease the operator may remove the epididymis alone with a long piece of the vas deferens leaving the body of the testis and most of its vascular supply intact Fair results have been obtained though rapid healing is less likely than after complete removal

the fingers draw the prepuce forward and thus finally reposition is effected

For more advanced cases reposition becomes impossible, and then the narrow constricting band caused by the orifice of the prepuce must be divided on the dorsal aspect This

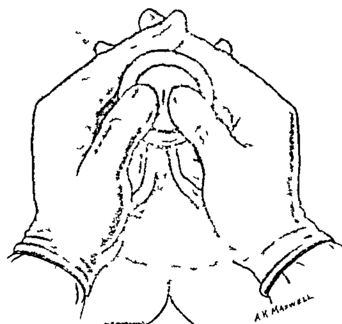


Fig 211 —Reduction of paraphimosis

is best done by an incision through the prepuce on the dorsum made with scissors down to the corona The raw edge of each side is caught up with one or two fine catgut sutures for hæmostatic purposes It is surprising how good a cosmetic result ensues when the œdema subsides Most patients will not agree afterwards to formal circumcision

easily performed by inserting the closed blades of a pair of artery forceps and gently opening them

Full retraction of the prepuce breaks down any adhesions which may have existed between the mucous membrane lining the inner side of the prepuce and that which covers the glans The prepuce is now drawn fully forward and two artery forceps are placed side by side along the dorsum and extending to a quarter of an inch of the corona A similar pair are placed on the under surface of the prepuce on either side of the frenum and the prepuce is divided by means of scissors between the two dorsal forceps The scissors are then turned through a right angle of the skin and mucous membrane and the prepuce is divided around each side of the penis at a distance of about a quarter of an inch from the level of the corona until the point of the pressure forceps on the under surface of the prepuce is reached A cuff of mucous membrane and skin is then left around the glans at the level of the corona and interrupted fine catgut sutures are placed at regular intervals in order to approximate the two special care being taken to secure the small vessels on either side and in the region of the frænum of the penis Great care must be taken to secure hæmostasis as otherwise a hæmatoma readily develops and may cause the wound to break down A dressing of ribbon gauze smeared generously with calamine ointment is applied

The most frequent mistake made is that of taking away too much skin and leaving too much mucous membrane

II Paraphimosis

This condition is due to the narrow orifice of the prepuce getting behind the corona and is characterized by great œdema and congestion not only of the exposed mucous membrane but also of the glans itself Treatment consists in forcible replacement of the prepuce This is accomplished by grasping the penis between the first and second fingers of each hand and compressing the glans penis with the thumbs so as to empty the vessels and diminish the amount of œdema present and thus reduce its size (Fig 211) At the same time

secured with catgut ligatures (Fig 212) Of these vessels the chief are the artery in the centre of each corpus cavernosum (9 and 9 in Fig 212) and the dorsal arteries and vein (7 and 8) The tourniquet is now removed and any bleeding points are dealt with

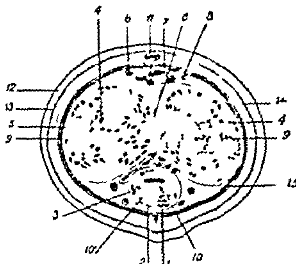


Fig 212—Section of penis showing the vessels requiring ligature in amputation through the organ

([illegible])

1 Urethra 2 and 3 corpus spongiosum 4 4 and 5 corpora cavernosa 6 median septum 7 dorsal vein 8 and 8 dorsal arteries 9 and 9 arteries of corpora cavernosa 10 and 10' arteries of corpus spongiosum 11 additional dorsal vein [illegible] skin 12 skin of penis 13 dartos layer 14 cellular tissue 15 fascial sheath

A small incision is made through the base of the dorsal flap and the stump of the urethra drawn through this opening the end of the urethra is notched on both sides so that it can be everted and sutured all round to the margin of the opening in the flap The edges of the latter and of the skin below are then sutured Either fine silk or catgut may be used—the latter has the advantage of not requiring subsequent removal It is almost impossible to keep any dressing applied

III Amputation of the Penis

The usual indication for this operation is epithelioma, which usually commences in the glans penis under a long tight prepuce

Special instruments required—An elastic band tourniquet, a gum elastic catheter, a narrow, straight bistoury, volsella forceps

Amputation of the free portion of the penis by dorsal flap—The hair about the root of the penis having been shaved off, the parts are rendered as aseptic as possible in the usual way The patient lies in the dorsal position with the thighs slightly abducted, the surgeon stands on the right side of the patient Before the operation the rectum and bladder should have been emptied A rubber catheter is left in the urethra if practicable An elastic tourniquet—a No 9 soft rubber catheter answers admirably—is tied around the root of the penis The tourniquet must be prevented from slipping forwards by applying it behind a sterilized hare lip pin used to transfix the penis

The end of the penis is then held by an assistant with the volsella forceps and a rounded dorsal flap of skin and fascia shaped out and dissected up This flap must be of sufficient dimensions to cover the whole section of the penis and it should be made well behind the edge of the epithelioma The flap being held back the penis is transfixed with a narrow bladed bistoury between the corpus spongiosum and the corpora cavernosa The catheter in the urethra will act as a guide between these The blade of the knife is then turned upwards and the two corpora cavernosa are divided at the level of the base of the skin flap

The urethra is now dissected out for nearly an inch in front of the point where the knife was introduced and severed at this level the catheter having of course been withdrawn The skin on the under surface of the penis is divided transversely from one side of the dorsal incision to the other There has been hitherto no hæmorrhage and before removing the tourniquet all the chief arteries and veins are carefully

PART XII—OPERATIONS ON THE RECTUM

CHAPTER I

OPERATIVE TREATMENT OF HÆMORRHOIDS

BEFORE any operation is performed on the rectum or anal canal it is essential that sigmoidoscopy should be carried out

Sigmoidoscopy is employed for examining the upper part of the rectum and the lower sigmoid The instrument (Fig 213) consists of a hollow straight tube 14 inches long



Fig 213 —Modern sigmoidoscope with proximal lighting

with its length marked on the outside so that one may know how far it has been introduced Suitable arrangements are made for distending the bowel with air and for illuminating and seeing its interior *An obturator is used to facilitate its introduction in the first instance* but is withdrawn when it is within the bowel There is no danger in the use of the sigmoidoscope provided that throughout the instrumentation the lumen of the bowel is kept well in view

hence complete hæmostasis should have been secured before the flap is sewn down Boric acid powder may be dusted on the suture line It is well to leave long the ends of two of the sutures which secure the new meatus as they facilitate the passage of a catheter during the next day or two However as a rule the patient will be able to pass his urine without an instrument It will be seen that by this method no raw surface is left requiring slow cicatrization with its attendant risk of stricture Healing is therefore rapid and the patient need not be kept in bed for more than a week or so One point in the operation is of special importance to take plenty of time in securing all bleeding vessels before the flap is sewn down The use of the tourniquet is essential *If any lymphatic glands in either groin are enlarged they* should be excised at the same time as the amputation of the penis This is done through an oblique incision on one or both sides the cut running parallel to Poupart s ligament A complete dissection out of glands from both groins is however a serious procedure to be avoided if possible The wounds are apt to do badly and the lymph return from the lower limbs is greatly interfered with

Note—In nearly all cases of epithelioma of the penis it is practicable to do the above operation leaving a stump however short It is superior to the more extensive removal of the whole penis and testes with the formation of a meatus in the perineum—which should never be done if the lesser procedure can be carried out

For early tumours confined to the glans radium treatment gives good results Interstitial radium is used with care not to let the needle penetrate the urethra or a stricture is liable to result A steel sound is usually passed until the needles have been placed Catheter drainage is necessary whilst the needles are present

be self holding), blunt pointed scissors, straight and curved on the flat.

The patient is anæsthetised Clover's crutch is applied and the patient is placed in the lithotomy position the buttocks being brought close to the lower end of the table The surgeon sits facing the perineum The skin of the perineum and the anus are swabbed over with a solution of perchloride of mercury, iodine or Dettol

1 LIGATURE OF EACH HÆMORRHOID FOLLOWED BY EXCISION BEYOND THE LIGATURE

The aim of the operation is to remove the hæmorrhoids and to leave adequate intact intervening skin and mucosal

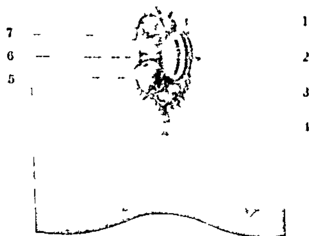


Fig 215 —Internal Hæmorrhoids

1 —Left anterior secondary 2 —Left anterior primary 3 —Left posterior secondary 4 —Posterior secondary 5 —Right posterior primary 6 —Right lateral secondary 7 —Right anterior primary

An examination of the anal canal and lower part of the rectum by a gloved finger will give useful information as regards the position of the piles (Fig 214)

The position of the piles in the anus is determined by the location of the superior hæmorrhoidal arteries That on the right side divides into two branches a right anterior and a right posterior distributed to the corresponding segments of the anal canal That on the left side continues down with its accompanying veins midway between the anterior and posterior points of the anal canal Thus it will be seen that it is possible for eight piles to form three primary and five secondary although the anterior one is very rarely seen (Fig 213) The three primary piles are usually sited as being in the 3 7 and 11 o clock positions (with the patient in the lithotomy position)

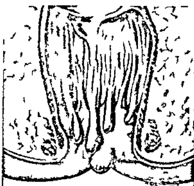


Fig 214 —Drawing showing several internal piles and one external one

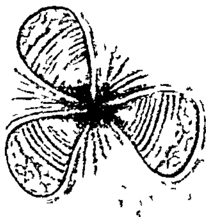
The best method of treatment of hæmorrhoids is by excision and ligature of the base and only this operation will be described

Preparation of the patient —The patient should be admitted to hospital at least 48 hours before operation The bowels are well opened by an aperient and rectum should be washed out not less than three hours from operation making sure that all the injected fluid is returned

A hot bath should be taken on the evening before the operation

Instruments required —Clover s crutch pile holding forceps (there are many forms of these forceps—the best have large blunt rounded or triangular ends which are per forated laterally and the handles of which catch so as to

membrane, its vessels and the longitudinal muscle coat As the vessels come from above and run just beneath the



B

Fig 216 B

mucous membrane and enter the upper part of the hæmorrhoid, this detachment is readily and safely accomplished, and

bridges from which regeneration can take place to cover the raw area

The first step is to expose or prolapse the three primary piles and apply a forceps to each pedicle thus producing a triangle of exposure These forceps are held by the assistants in the 3 7 and 11 o clock positions

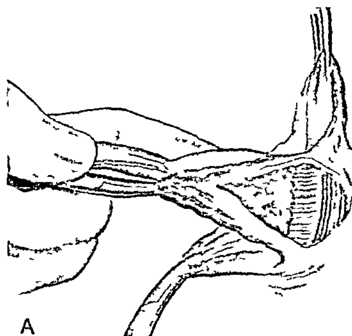


Fig 216 —Diagrams showing the operative procedure for ligature and excision of hæmorrhoids

The piles are dissected up in turn commencing with the left lateral and then the right anterior

A V shaped cut is made through the skin and perianal plexus opposite the pile and the perianal space is opened up The pile is dissected up until it is attached only by mucous

of absorbent wool is then secured in place by a firm T bandage It is customary to insert a suppository containing a quarter to half a grain of morphia within the rectum before applying the dressing

The tube is removed in 24 hrs by gentle traction on the attached suture The gauze dressings are left intact

Every patient should be thoroughly examined and pre pared before a hæmorrhoidal operation and again a few weeks after it to make sure that there is no undue contraction Should such be found it can be cured by digital dilatation at that stage A real stricture should be most exceptional

Injection method—This form of treatment is in valuable for piles which bleed and do not prolapse as it is possible to treat the patient in easy stages and without interfering with his normal routine of life About 2 ccs of 5 per-cent solution of carbolic in almond oil is injected sub mucously in the region of the base of the pile with the idea of producing local fibrosis which will strangle the vessels at the site of the injection It is to be noted that the injection is not made into the vein but into the perivascular tissue The operation is a painless one and requires no anæsthetic and the results are very satisfactory Three courses of injections at three weekly intervals usually suffice The use of a procto scope which is illuminated from within by means of a small lamp and the adoption of the knee elbow position greatly facilitate the operation

the bleeding is not great The detachment should be sufficiently extensive to form a deep groove between the subcutaneous external sphincter and the pile pedicle

The forceps are now handed to an assistant, who maintains a traction upon the pile while the surgeon places a thick silk ligature round its pedicle which he at once proceeds to tie as tightly as possible to strangle it Some surgeons transfix the pile for added security

Before tightening the knot the ligature should be so manipulated as to include the highest part of the mucous membrane left attached to the pile

There are two points to be specially attended to in applying the ligatures The groove in which each lies must be made within the margin of the external sphincter, so that the ligature includes no part of the muscle Secondly there must be no risk of the ligature slipping after the stump has been returned for most troublesome hæmorrhage may then result The tighter it is tied the better and a third knot should be made for security The scissors should not cut too closely to the ligatures

Most secondary piles can be included in the perianal incision It is better to leave these if their removal would jeopardize the creation of a skin bridge

The operation is completed by cutting off the ligatures and by snipping away about two thirds of the strangulated hæmorrhoidal tissues which project beyond the knot The parts are lightly dried and returned within the sphincter The operation site will consist of three raw areas in the perianal region (Fig 216B) These should be made flat by snipping off any tags with scissors but leaving intact the internal mucocutaneous bridges A few perianal vessels may have to be ligated with fine catgut

A small tube about ½ inch in diameter and 3 inches long with a silk handle attached is inserted into the rectum, to reveal any concealed bleeding and allow flatus to escape Round the tube three small corners of vaseline gauze are inserted to cover the raw areas

A soft pad of moistened gauze over which is a square pad

brought outside the anus Nothing then remains but to slit up the fistula with a sharp pointed curved bistoury

When the inner opening is high up, persistent attempts to bring the point of the director out of the anus may lead to undue laceration of the part

In such a case, the sphincter having been very fully dilated, the interior of the bowel must be well exposed by means of a suitable speculum and well illuminated by means of a small electric lamp The division is then made while the parts are in full view of the operator If it be found that complete division would mean extensive section of the sphincter muscles, it would be best to avoid this by opening the lower part of the track and scraping out the upper

After the division of the fistula comes the most delicate part of the operation—the search *for a secondary fistula for* burrowing tracks and for diverticula from the primary sinus

Any secondary sinuses must be treated as their condition indicates Those which burrow beneath the mucous membrane should be slit up for their entire length No object is gained by sparing the mucous membrane, and hesitating and incomplete incisions will always be regretted A common form is the horseshoe fistula in which a single aperture at the posterior aspect of the anus is found to lead on either side *to a fistula which curves round the greater part of* the anal circumference If this is found the track must be opened up in its whole length Secondary sinuses which pass away from the rectum must be liberally slit up When this involves too great a division of the soft parts they may be freely opened into the original wound may be dilated with dressing forceps and the finger well scraped with a sharp spoon or seared *with the electro-cautery* and then packed

All the pulpy granulation tissue which is met with about fistulæ should in every case be scraped away The surgeon should endeavour to leave as clean and fresh a wound as possible

After freely opening all sinuses it is most important to cut away a generous margin of skin on either side of each incision

CHAPTER II

OPERATIONS FOR ANAL FISTULA AND FISSURE

ANAL FISTULA

THE operation should never be done while the parts are much inflamed or there is free discharge of pus the surgeon should wait until the fistula has become chronic with only slight discharge

Operation —The patient is prepared in the same manner as is described in the previous chapter He is placed in the lithotomy position, and is secured there by a Clover's crutch This position is much more convenient than the lateral one

It is assumed that an external opening to the fistula exists and that it is a complete one A probe pointed director is introduced into the fistula and is passed into the bowel through the internal opening Not the very least force must be employed The internal opening may have been already detected and the passing of the probe may be carried out while a speculum keeps the inner opening in view If the director does not easily pass a flexible or specially bent probe may be introduced If the probe is found to present under the thinned mucous membrane in a case in which no internal opening exists the point of the director should be thrust through the mucous membrane at the thinnest spot In every case when possible the probe should be passed while the *left* forefinger occupies the rectum and acts as a guide

In a simple case in which the inner orifice is low down the point of the director may be engaged upon the tip of the left forefinger (lying in the rectum) and may be cautiously

Anal Fissure

Surgical treatment may be required when other methods of treatment of this painful condition have failed

The most effective is to divide the subcutaneous external sphincter transversely with scissors, and at the same time excise the fissure and sentinel pile via a V shaped incision at the anal margin The fissure which is a linear ulcer maintained by sphincter spasm is now allowed to heal

so as to convert it from a deep narrow cleft to a wide shallow wound This will heal from the bottom by granulation tissue and the skin margins will not come together and unite prematurely The wound is packed with wool which is readily soaked out in a warm bath each day

In the division of the fistula part of the external sphincter is as a rule divided and in order that the section of the muscle fibres should be as direct as possible the knife should always cut its way into the bowel at right angles to the anal margin. Permanent incontinence is hardly to be feared from division of the sphincter at one point but in bad cases of fistula the operator should be most careful to avoid cutting this muscle across at more than one point of its circumference otherwise incontinence is almost certain to result

If any piles exist they should be removed at the time of the operation and all ill nourished flaps and tags of inflamed and undermined skin should be cut away

All bleeding vessels should be tied and the wounds lightly packed with sterile wool or gauze and secured by a T bandage.

Acute Ischio rectal Abscess —Any abscess in this region should be opened at once since any delay increases the risk of a fistula Under anæsthesia a cruciate or T shaped incision is made and the flaps are cut away to allow adequate drainage (Fig 217) If the abscess has extended to the other ischio rectal fossa both sides and the communicating track should be laid open and lateral relieving incisions made At the end of the operation the wound should be packed with wool soaked in Milton and after its removal irrigations and baths of Milton should be employed It is essential that all wounds in this region should heal from the deepest part

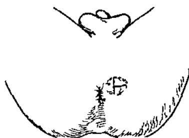


Fig 217 —Situation of T shaped incision required for opening an Ischio rectal abscess

widely, and the mobilized bowel is passed up into the abdomen The peritoneal suture to repair the pelvic floor is commenced from below, then locked and completed from above The operation is then completed through the abdominal incision

Advantages

1 The reconstruction of the pelvic floor is performed over an empty pelvis and is therefore easier in some cases

2 Division of the colon is carried out extraperitoneally, and risk of peritonitis is therefore diminished

I PERINEAL EXCISION OF THE RECTUM

Procedure

A small abdominal excision is made so that the surgeon s hand may be inserted to explore the abdomen A left iliac permanent loop colostomy is then performed and the abdomen closed Perineal excision is then performed the initial stages being as described for the perineal part of abdomino perineal resection (Fig 218) When the rectum and sigmoid have been mobilized as high as possible the superior hæmorrhoidal vessels are ligated as high as possible The sigmoid is then divided, the proximal stump of colon is closed and oversewn and the stump is sutured to the pelvic peritoneum as this is closed to reform the pelvic floor The perineal wound is then packed and partially closed

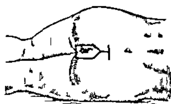


Fig 218 —Outline of incisions made in the perineum in excision of the rectum

Disadvantages

1 Only incomplete removal of the lymphatic drainage field is possible in this operation

2 It is unsuitable for high rectal growths

Advantages

1 This operation is suitable for some early and low growths of the rectum

CHAPTER III

OPERATIONS FOR CARCINOMA OF THE RECTUM

Preparation

1 Blood transfusion is advisable and is best started as soon as it is decided to proceed with the radical operation

2 A catheter should be passed pre operatively and left *in situ* It later serves as a guide and therefore protection to the urethra

3 The bladder should be emptied by compression by the closed fist above the symphysis pubis The fist should not be released until a spigot has been inserted in the catheter so that air cannot be sucked back into the bladder The emptier the bladder the more room there is in the pelvis

General consideration

1 Operations on the rectum may be performed in one or two stages A preliminary colostomy should always be performed in the presence of obstruction

2 Wherever anastomosis is performed it should be preceded by a defunctioning temporary colostomy

3 Two surgical teams may combine to perform a synchronous abdominal and perineal operation

4 High Trendelenburg position is important when operating in the pelvis from the abdomen The lithotomy position or left lateral position may be used for Perineal operations

Other procedures

A preliminary abdominal exploration is performed to determine operability

The perineal resection is then performed as described in the Abdomino perineal operation the dissection being carried up to the peritoneal pouch The latter is opened up

widely and the mobilized bowel is passed up into the abdomen. The peritoneal suture to repair the pelvic floor is commenced from below then located, and completed from above. The operation is then completed through the abdominal incision.

Advantages

1 The reconstruction of the pelvic floor is performed over an empty pelvis and is therefore easier in some cases.

2 Division of the colon is carried out extraperitoneally and risk of peritonitis is therefore diminished.

I. Perineal Excision of the Rectum

Procedure.

A small abdominal excision is made so that the surgeon's hand may be inserted to explore the abdomen. A left iliac permanent loop colostomy is then performed and the abdomen closed. Perineal excision is then performed, the initial stages being as described for the perineal part of abdomino-perineal resection (Fig 218). When the rectum and sigmoid have been mobilized as high as possible the superior hæmorrhoidal vessels are ligated as high as possible. The sigmoid is then divided, the proximal stump of colon is closed and oversewn, and the stump is sutured to the pelvic peritoneum as this is closed to reform the pelvic floor. The perineal wound is then packed and partially closed.



Fig 218 —Outline of incisions made in the perineum in excision of the rectum

Disadvantages

1 Only incomplete removal of the lymphatic drainage field is possible in this operation.

2 It is unsuitable for high rectal growths.

Advantages

1 This operation is suitable for some early and low growths of the rectum.

rhoidal vessels, in these cases catgut ligatures must be applied

Attention is now paid to the anterior surface of the rectum With blunt-pointed scissors the space between the rectum and the vagina in the female or the seminal vesicles in the male is opened up The surgeon then inserts a finger and continues the separation of the rectum anteriorly

In some cases the rectum can be mobilized almost completely by finger dissection from above but according to the degree of peri rectal inflammation or infiltration by growth a varying amount of cutting with long blunt-ended scissors must be practised

The sigmoid colon must now be inspected and the lower limit of good vascular supply determined by observation of pulsating vessels and by cutting and observing bleeding

The mesocolon is divided and bleeding points in it ligatured from the site of section of the inferior mesenteric vessels to the proposed site of division of the bowel

Various methods of division of the bowel may be used one of the most satisfactory is with the aid of Cope s modification of de Martel s clamp This instrument simultaneously applies three small crushing clamps to the bowel closely adjacent to each other The middle one is then removed and the bowel can be divided across a crushed area The two ends of sigmoid are closed by the two lateral clamps

A left iliac colostomy is now completed the proximal end of the sigmoid with its clamp still *in situ* being passed through the incision in the left iliac fossa (*see* Colostomy p 348)

The distal end of the sigmoid is now inserted into a sterile rubber glove the clamp being first removed the glove is tied on to the bowel with silk to avoid escaping bowel contents The sigmoid and rectum are now pushed down into the hollow of the sacrum as far as possible

The peritoneal floor of the pelvis must be reformed The cut edges of peritoneum are picked up with forceps and the parietal peritoneum is mobilized gently with the fingers and sutured with continuous catgut on an atraumatic needle Sufficient peritoneum to reform the pelvic floor must be

obtained from wherever possible In the male it may be stripped off the bladder in the female from the lateral pelvic wall The floor of the pelvis is closed completely over the lower segment of bowel and the stump of the inferior mesenteric vessels is also buried beneath the peritoneum A purse string suture of catgut on an atraumatic needle is inserted to close the gap between the proximal end of the sigmoid as it passes to the colostomy, and the lateral abdominal wall The abdomen is closed in layers

The patient is now placed in lithotomy position with a sand bag underneath the sacrum The skin of the buttocks and anal region is cleansed and a silk purse string suture is inserted to close the anus An incision is made encircling the anus 1 inch from the mucocutaneous junction and is prolonged backwards inclining slightly to the left of the mid line and extending as far as the sacro coccygeal junction The incision is deepened throughout, and the ischiorectal fossæ are opened up Posteriorly the incision is deepened to the bone and the coccyx is disarticulated from the sacrum The skin flaps over the ischiorectal fossæ are retracted laterally with Lane s tissue holding forceps and the coccyx is lifted forwards The tense deep fascia underlying the coccyx is incised the index finger of the left hand is insinuated beneath the levator ani and this muscle is divided with scissors lateral to the finger, first on one side and then on the other Each levator ani is completely divided from behind forwards to a point in front of the sutured anus All bleeding points are now picked up and ligatured

The sigmoid colon can now be delivered from the hollow of the sacrum and the rectum is found to be anchored only by its anterior attachment the puborectalis This attachment is best freed from the perineal aspect by the use of blunt-pointed scissors care being taken not to inflict any injury to the rectum posteriorly or the urethra or vagina anteriorly Slight tension on the bowel at this stage reveals any undivided attachments These can be divided and the rectum and sigmoid are removed

Retractors are now used to open up the cavity for

inspection Complete hæmostasis is obtained, the cavity is dusted with penicillin and sulphonamide powder A large sheet of perforated oiled silk is inserted to line the cavity which is then packed with gauze soaked in flavine and paraffin emulsion The anterior and posterior extremities of the perineal wound are closed with interrupted silk eversion sutures leaving 2 inches in the centre of the wound through which the gauze packing and oiled silk extrude

PART XIII—OPERATIONS ON THE HEAD AND SPINE

CHAPTER I

TREPHINING

I TREPHINING IN FRACTURE OF THE SKULL

The control of hæmorrhage —This problem has always been one of the most serious to confront the surgeon in his attempt to approach the brain and various forms of tourniquet and pressure forceps have been devised all of which are more remarkable for their ingenuity than for their efficiency The most satisfactory advance that has been made in this direction is the routine use of generous quantities of local anæsthetic injected under pressure into and under the scalp thereby obliterating many of the smaller vessels and producing a thickness of tissue which can readily be grasped by ordinary artery forceps The skin incision is always carried down to the bone and artery forceps are applied at frequent intervals to the aponeurotic layer This is forcibly exerted over the skin margin by means of these forceps and complete hæmostasis secured

Venous oozing from the diploe after trephining is sometimes considerable in amount especially in cases of exploration for cerebral tumour Pressure with gauze is the chief method of overcoming it Horsley s wax is recommended

Meningeal arterioles running on the outer surface of the dura mater perhaps in grooves or tunnels in the bone, are apt to be torn by the trephine If hæmorrhage is trouble

inspection Complete hæmostasis is obtained, the cavity is dusted with penicillin and sulphonamide powder A large sheet of perforated oiled silk is inserted to line the cavity which is then packed with gauze soaked in flavine and paraffin emulsion The anterior and posterior extremities of the perineal wound are closed with interrupted silk eversion sutures leaving 2 inches in the centre of the wound through which the gauze packing and oiled silk extrude

ether A solution of iodine (2 per cent) in absolute alcohol is painted on before commencing the operation

The head is conveniently supported upon a sand bag covered with mackintosh sheeting and sterilized towels

Operation.—When any wound already exists, it should be excised When the scalp is sound a straight or slightly curved incision is made and carried at once down to the bone The periosteum is freely detached on each side by means of an elevator and the wound is widely retracted

The fracture is now exposed and examined It may be found to be at once possible to introduce an elevator beneath

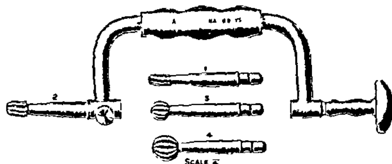


Fig 219 —Brace and graded cutting bits for trephining

the depressed bone and to elevate it Fragments at the same time may often be readily removed by means of dressing forceps or necrosis forceps

In other cases a rim of projecting bone—belonging to the sound part of the skull—may be removed with a narrow chisel and a mallet, or with the gouge or gouge forceps, and a little space is at once provided beneath the bone which will allow of an elevator being introduced

The elevator must be introduced with care It is apt to slip though such an accident is not likely with Horsley's instrument In raising the depressed bone it is needless to say that the elevator must be supported upon the sound part of the skull

Sometimes when the bone is much comminuted, one frag

some from these, it must be checked either by pushing in the dura with an elevator enlarging the bone aperture with rongeur forceps, and then passing fine silk sutures beneath the vessels on either side of the laceration, or by plugging the osseous foramen with a spicule of bone cut from the part removed in trephining Here again the use of Horsley's wax is recommended

Finally it may be noted that occasionally one of the large sinuses, e g the superior longitudinal (sinus sagittalis superior) is opened during the course of the operation Plugging with gauze will control the hæmorrhage, but the plug must be left in for two or three days and then cautiously removed the wound having been left somewhat open Rigid care should be taken as to asepsis

The use of diathermy has made a tremendous difference to the ease and bloodlessness with which these operations can be performed Blood vessels up to the size of the middle meningeal artery are readily obliterated by a touch from the coagulating electrode

Indications for operation.—(1) All cases of depressed fracture whether compound or not Note the danger of mistaking a cephalhæmatoma in a child for a depressed fracture, note also that a depression over the frontal sinus region is hardly a true depressed fracture of the vault (2) Punctured fractures—those caused by a pointed or sharp instrument (3) Cases of simple fracture or of head injury in which the symptoms point to compression of brain from extradural or localized intradural hæmorrhage

Special instruments required—A special brace with a graded series of cutting bits (Fig 219) bone nibbling forceps in the absence of the special brace a 1 inch trephine a slender chisel and mallet a gouge two pairs of gouge forceps an elevator periosteal rugine necrosis forceps scalpels fine toothed forceps and fine scissors for the dura mater slender curved needles for carrying a ligature through the dura mater and suitable needle holder

Preparation of the patient.—The head is shaved then washed with soap and water It is next washed with

ether A *solution of iodine (2 per cent) in absolute alcohol is* painted on before commencing the operation

The head is conveniently supported upon a sand bag *covered with mackintosh sheeting* and sterilized towels

Operation.—When any wound already exists it should be excised When the scalp is sound, a straight or slightly curved incision is made and carried at once down to the bone The periosteum is freely detached on each side by means of an elevator and the wound is widely retracted

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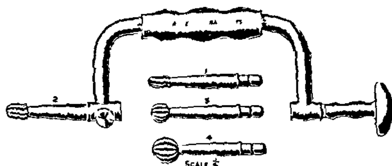


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Sometimes when the bone is much comminuted one frag-

ment will be found to be so tilted outwards that it can be *seized* and removed and through the gap *thus left the elevator* or the blade of the dressing forceps or necrosis forceps can be introduced

In certain cases it will be necessary to make an opening in the skull adjacent to the depressed bone and then by introducing an instrument through the opening, to elevate the fragment from within The special instruments already mentioned (Fig 219) are used for this purpose and while they are in use a steady stream of sterile lotion is directed upon them in order to keep the cutting surfaces cool and to wash away bone dust as it forms *If by any* unfortunate circumstance such instruments are not *available it may be necessary* to use the old fashioned trephine (Fig 220)

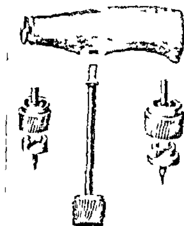


Fig 220 —Trephine

Depressed fragments which still retain a hold upon the sound bone are left in position after they have been elevated Careful search should be made all round the opening for small sharp *fragments* which are *often found* displaced *under the bony* edge They are easily missed, and if left are very apt to cause subsequent trouble (cerebral irritation, traumatic epilepsy etc) Scalp hairs or other foreign bodies are some times found driven into the wound Examination of the bone aperture being now completed, and the operator having made certain that no further depression has to be rectified or loose spicules removed the condition of the underlying dura and brain is inspected Here again a spicule of detached bone may have to be extracted Any rent in the dura should be *sutured with fine silk if practicable*

The edges of the opening in the bone are finally smoothed off with the rongeur or the gouge

The flap or flaps of scalp are now brought into place by silkworm gut sutures No drainage is required

Note on trephining for depressed fracture of the vault in young infants, due to birth injuries—The peculiar features of these depressed (simple) fractures are well known In all but the slighter cases it is advisable to operate The smallest trephine (half an inch in diameter) will suffice it is applied at the edge of the depression The dura mater being gently detached the whole depressed area of bone is cut away by a circumferential incision with blunt pointed scissors This piece is lifted off its shape rectified by finger pressure as far as practicable and reinserted in the inverted position—i e with its former dural aspect turned out wards (Nicholl) The attempt to elevate the depression in any other way usually fails The results have been very good when the operations have been done quickly and with little bleeding

The position of the branches of the middle meningeal artery—a frequent source of bleeding after fracture of the skull—is shown in Fig 247 p 529

II Trephining for Intracranial Hæmorrhage

In most cases this will be performed for extradural hæmo rrhage associated with the symptoms of increasing cerebral compression and coming on usually after some interval between the injury and the onset of these symptoms In the great majority there is a linear fracture which has torn the anterior main branch of the middle meningeal artery from this rent the blood detaches the dura from the bone chiefly in the downward direction as far as the foramina ovale and rotun dum In a few cases the posterior meningeal branch (Fig 244 p 521) is the one torn here position of clot and site of operation will differ from the above Occasionally there is no fracture at all, and in many cases there is no scalp wound to help in determining the side on which the extra dural hæmorrhage has occurred The mortality attending this lesion is very grave and the only chance of recovery

lies in early recognition of the symptoms and extreme promptitude in operating

Cerebral compression by hæmorrhage will be diagnosed from (1) the interval (2) full, slow high tension pulse (3) stertorous breathing (4) dilatation of the pupils with corneal anæsthesia (5) convulsive movements or rigidity of the limbs going on to paralysis (6) deepening unconsciousness

Apart from the site of injury to the vault (if known) the side of the skull on which to trephine will be determined

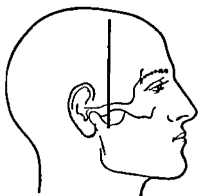


Fig 221 —Incision for exposing the meningeal artery

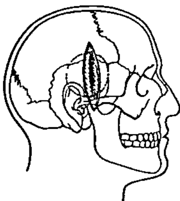


Fig 222 — The temporal muscle is split in the direction of its fibres and the skull opened as shown in the dotted circle

by (1) the pupil *on the same side* being the first to become widely dilated and fixed the cornea on the same side being most anæsthetic and (2) the arm and leg *on the opposite side* to that of the hæmorrhage being first and most affected Œdema of the optic disc and dilatation of retinal veins may be present on the same side Note that very occasionally meningeal hæmorrhage has occurred *on both sides of the skull*

The operation —The whole scalp has been shaved and thoroughly disinfected The incision is shown in Fig 221 and is carried immediately down to the bone (Figs 222 223)

The point for insertion of the drill is situated about 2 inches behind the external angular process and the same distance above the zygoma The aperture can be readily enlarged with bone nibbling forceps

The skull opened, soft blood clot wells up from outside the dura Bone is cut away, especially in the downward direction until free access is obtained and the clot removed with small pieces of sponge in holders by irrigation with hot water or even by a Volkmann s scoop

With the aid of a head lamp, careful search is made for the bleeding artery If this is found it is secured by passing two threaded needles through the dura on either side of the rent and then tying firmly Silver clips (advocated by Cushing for Gasserian ganglion operations) may be applied

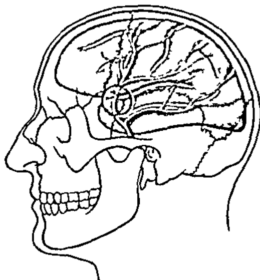


Fig 223 —Site of opening in the skull which is required for middle meningeal hæmorrhage

Plugging with gauze *should not be used* to avert arterial hæmorrhage this method is both inefficient and dangerous Plugging a venous sinus is an entirely different matter

If the bleeding spot cannot be localized, one of two courses can be tried (1) The foramen spinosum is plugged with a small spicule of bone or a piece of boiled match stick It may be difficult to find the foramen as the clot obscures the relations, in which case (2) the external carotid artery is tied below the jaw

Note that the bleeding spot is always to be looked for on the outer surface of the dura mater, which has been pushed inwards by the clot. Hæmorrhage from the region of the foramen spinosum is of extreme rarity.

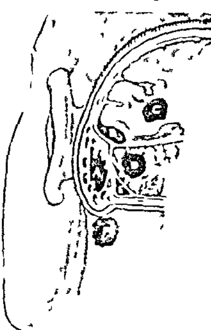


Fig 224 —Diagram representing the course of inflammatory trouble from suppurative disease of the middle ear

A dilated and infected mastoid antrum B subcranial (extradural) abscess from infection through the roof of middle ear or mastoid C abscess in temporo-sphenoidal lobe D cerebellar abscess through lateral sinus E Bezold's mastoid process (? formation of tip of mastoid process)

The wound is closed by means of interrupted silkworm gut sutures.

If trephining in the region described above has failed to discover any extradural extravasation, it is probably best to make a short incision through the dura mater in order to see if there is one within this membrane. Or a second aperture may be made over the posterior branch of the middle meningeal artery (Fig 223 B). A fresh incision must be made, the point of the trephine being inserted about 1 to 1½ inches above Reid's base line opposite the anterior border of the mastoid process. Bathe Rawling gives the meeting point of two lines—one drawn vertically up from the back of the mastoid, the other parallel with Reid's base-line and drawn from the top of the orbit. The fact is that in trephining for meningeal hæmorrhage (from either anterior or posterior branch) the exact landmarks laid down are not of great importance.

If the symptoms point strongly to compression but the hæmorrhage is not found, it may be worth while to trephine on the opposite side of the skull

We have known one case in which trephining over both branches of the artery in the orthodox positions failed to reveal the clot and the attempt was given up At the post mortem a large extradural hæmorrhage was found high up, its lower edge having been missed by only an inch !

Comment on the results of the operation —Every thing depends upon early recognition and promptitude in carrying it out Some statistics show 75 per cent of recoveries, this gives too favourable an impression It is important to remember that many patients die from extra dural hæmorrhage after injuries to the head who might have been saved by early operation

III Trephining for Abscess in the Brain

In the great majority of cases abscess of the brain is chronic is secondary to middle ear disease and is situated in the temporo sphenoidal lobe The site next in frequency is the cerebellum The proportion differs at various ages In children under 10 in 87 per cent the abscess was in the temporo sphenoidal lobe in 13 per cent in the cerebellum Of adult cases in 35 per cent the abscess was cerebellar The frontal lobe is occasionally the site

As middle ear disease is the usual cause exploration for cerebral abscess is often carried out in the course of a radical mastoid operation but it will be best to describe here the separate operations for draining an abscess in the two regions mentioned above

1 **The operation for temporo-sphenoidal abscess** —Define a spot 1½ to 2 inches above the external auditory meatus and mark the bone here through the scalp with a bradawl (Fig 225 c) Expose and open the skull in the manner already described and examine the exposed dura mater If there is increased intracranial tension (and probably an abscess) the membrane will bulge and not pulsate Ligature by ' under suturing ' any branch of

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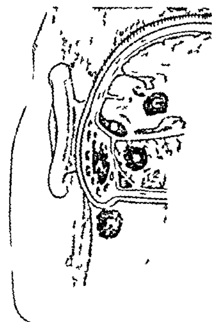


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A dilated and infected mastoid antrum B sub [illegible] (extradural) abscess from [illegible] through the roof of middle ear [illegible] mastoid C abscess in temp [illegible] lobe D cerebellar abscess [illegible] lat [illegible] E Bezold's abscess through perforation of tip of mastoid process

The wound is closed by means of interrupted silkworm gut sutures

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the meningeal artery that is exposed Make a crucial incision in the dura with scalpel aided by scissors and pass Horsley's pus evacuator or a trocar and cannula (which must not be too small) inwards and slightly forwards If the evacuator be used its blades are opened once for each quarter of an inch of brain substance traversed' (Sir W Macewen) so as to give the pus a chance of escaping If

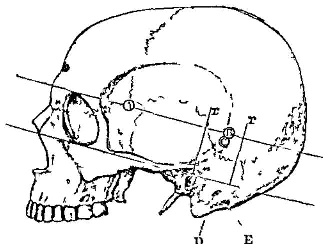


Fig 225 —Points for trephining

A B Spots for trephining in middle meningeal hæmorrhage C spot for trephining in abscess of the temporo sphenoidal lobe D mastoid foramen E, spot for trephining in abscess of the cerebellum

the trocar and cannula be employed, the former should be frequently withdrawn with the same object When pus escapes a pair of slender sinus forceps should be passed alongside the cannula to enlarge the track

Before the instruments are withdrawn an india rubber drainage tube is carefully introduced and secured by a skin suture or a safety pin a moist gauze dressing being then applied It is best not to syringe for the first few days for fear of spreading infection to the meninges and if it is

done later the utmost gentleness is required The tube will have to be retained two or three weeks, and is very gradually shortened. Repair in brain substance is very slow

2 **The operation for cerebellar abscess** —Make an incision along the posterior border of the mastoid process towards the superior curved line on the occipital bone and then backwards just below this line to the external protuberance As it is impossible here to employ any form of tourniquet the bleeding from the occipital artery etc will be very free unless the divided branches are immediately secured with Wells s forceps

All the soft parts together with the pericranium, are peeled downwards with a rugine until the inferior curved line is reached Care must be taken not to wound the trunk of the occipital artery The spot most suited for the introduction of the trephine will lie just below the latter line The bone here is very thin The lateral sinus (sinus transversus) lies opposite to the superior curved line (linea nuchæ superior) above and the mastoid process in front The spot for the trephine is a little behind and below the mastoid foramen (Fig 225, E) and the direction in which it should work is upwards and slightly inwards The bone may be removed with the trephine or, if more convenient with the gouge

The dura mater is incised and the abscess is opened and drained in the manner already described The evacuating instrument is passed into the cerebellum in the forward and inward direction If the skin and soft parts on being released are found to overlap the trephine hole, they must be divided in such a way as to leave the latter quite clear

It is recommended that as soon as the bone is exposed the mastoid foramen should be examined If pus has found its way along the groove of the lateral sinus, it may induce symptoms akin to those of cerebellar abscess and an examination of the foramen may reveal pus escaping, since that opening leads direct into the groove for the sinus

Note on chronic encapsuled abscess —Now and then it happens that an abscess with thick wall is exposed, for

which mere drainage is unsuitable In such a case, after evacuation of the pus, it is best to seize the wall of the abscess with forceps and to peel off the surrounding brain substance gently with a blunt instrument The hæmorrhage is seldom *severe, and the cavity left fills up with extraordinary rapidity* (Bathe Rawling) Light packing with gauze for a day or two may be advisable

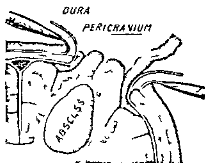


Fig 226 —Abscess cavity as found at second operation Partial herniation has taken place

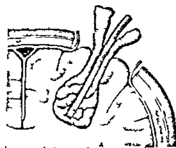


Fig 227 — Drainage of abscess with tube and gauze

Another method which has given good results consists in making a large burr hole in the skull over the abscess and enlarging the opening with rongeur forceps The dura mater is incised in a cruciate manner the triangular flaps retracted and the sub dural space surrounding the opening packed with gauze soaked with a weak solution of iodine The decompression allows the abscess to extrude itself towards the opening in the skull (Fig 226) After an interval of a week or ten days the abscess can be explored and drained (Fig 227)

Results of operation for cerebral or cerebellar abscess —Too little is usually said about the remote results in cases of successful drainage and the student is led to suppose that complete and permanent cure is the rule Apart from the fact that convalescence is very slow the destructive

effects of an abscess of any size on the cerebral functions are serious Hernia cerebri is one complication that may follow, extensive adhesions of brain to its case must of necessity result

Motor paralysis is perhaps rarely severe but impairment of cerebral power, headaches, visual defect etc, are often present for long after the wound has closed In not a few cases the patient is left a wreck and a complete cure is exceptional

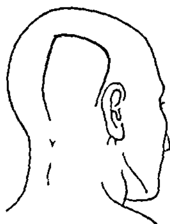


Fig 228 -Incision for approach and removal of parietal and occipital tumours

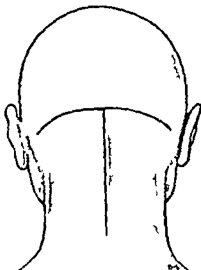


Fig 229 —The Cushing cross bow incision for exposing posterior fossa tumours

IV Operations for Cerebral Tumour

To diagnose the existence of a tumour involving the brain is not very difficult but to determine its exact position is far otherwise The task has been made much easier by the better understanding of the X ray appearances of the skull and by the development of the technique of ventriculography Removal of the tumour is only practicable if it is situated in the cortex or still better if it grows from

which mere drainage is unsuitable In such a case after evacuation of the pus it is best to seize the wall of the abscess with forceps and to peel off the surrounding brain substance gently with a blunt instrument The hæmorrhage is seldom severe and the cavity left fills up with extraordinary rapidity' (Bathe Rawling) Light packing with gauze for a day or two may be advisable

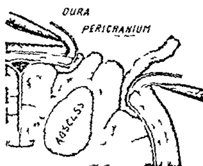


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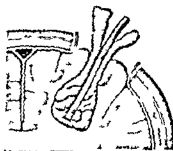


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Another method which has given good results consists in making a large burr hole in the skull over the abscess and enlarging the opening with rongeur forceps The dura mater is incised in a cruciate manner the triangular flaps retracted, and the sub dural space surrounding the opening packed with gauze soaked with a weak solution of iodine The decompression allows the abscess to extrude itself towards the opening in the skull (Fig 226) After an interval of a week or ten days the abscess can be explored and drained (Fig 227)

Results of operation for cerebral or cerebellar abscess —Too little is usually said about the remote results in cases of successful drainage and the student is led to suppose that complete and permanent cure is the rule Apart from the fact that convalescence is very slow the destructive

cerebri It acts mainly by allowing the cerebro spinal fluid to pass outside the skull and be drained away into the lymph system of the neck It also provides a window through which deep X ray therapy can be given to the growth and

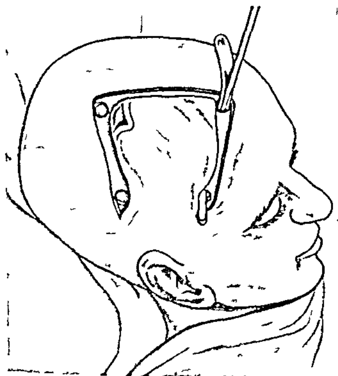


Fig 231 —Decompression operation

Four trephine holes have been made and a Gigli saw introducer passed

which will permit of expansion of the brain during the reactionary period which follows such treatment

The temporal region is by far the most suitable for decompression, here the bone is thin and the muscle is a convenient covering

the dura and involves the brain by pressure only without infiltration (meningioma or cyst)

The operation—An outline must here suffice An incision is made appropriate to the area to be exposed (Figs 228 229) and the wound widely retracted At each angle perforate the cranium with a burr or a small trephine midway between these openings add others connect all round with Gigli s saw (Fig 230) or a de Vilbiss cutting forceps or other means leaving the bone at the base of the flap to be fractured by wrenching outwards

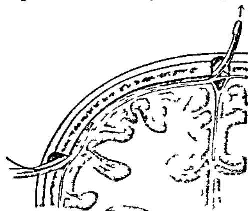


Fig 230 —Method of opening the skull by means of a Gigli saw and guide

The dura mater is freely incised and the cortex is carefully inspected and palpated, and if the tumour is found and is not an infiltrating one it is carefully shelled out by a blunt instrument (an ordinary spoon has frequently been found effective) If a cyst (serous or blood) is discovered it must be removed not drained

If no tumour is found or can be removed it is best to effect decompression by cutting away the lower part of the bone from the flap and leaving the dural wound open

Decompression of the brain is done with the object of relieving intracranial pressure in inoperable tumour cases (and the great majority of cerebral new growths cannot be safely removed nor even found at operation) It may relieve the terrible headache and vomiting of such cases and defer the onset of blindness but it is at the same time merely palliative and is inevitably followed sooner or later by increasing hernia

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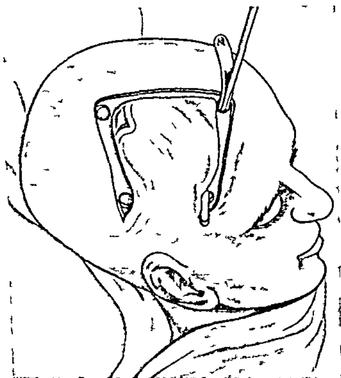


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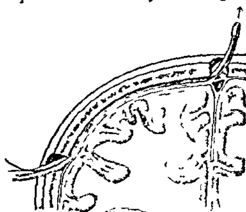


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The dura mater is freely incised and the cortex is carefully inspected and palpated and if the tumour is found, and is not an infiltrating one it is carefully shelled out by a blunt instrument (an ordinary spoon has frequently been found effective) If a cyst (serous or blood) is discovered it must be removed not drained

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Transfrontal Exposure of Pituitary Tumours — The transfrontal approach should be used for all supra pituitary tumours

The patient should be placed in the supine position with the head slightly extended over a sand bag An ear to ear incision is made starting about 2 cm above and in front of the ear and passing transversely across the head to the other side (Fig 233) The scalp is turned forwards over the face the supra-orbital vessels and nerves being preserved An osteoplastic flap is elevated outwards the temporal muscle acting as a hinge (Fig 233) The next step is to elevate the dura mater from the orbital roof and keep it retracted by means of a retractor The dura mater is gradually and very carefully separated by means of small rolls of cotton wool, until the ridge of the lesser wing of the sphenoid is reached On the medial side the separation is limited by the olfactory groove The dura mater is incised at the point of separation and the cerebro spinal fluid allowed to escape An illuminated retractor is now inserted through the opening in the dura mater and beneath the frontal lobe of the brain, and is then carefully and slowly retracted when the right optic nerve will gradually come into view As a result of the pressure of the tumour the optic nerve may be flattened The pituitary tumour will be seen to the inner side of the optic nerve and the internal carotid artery may sometimes be seen lying to the outer side of the optic nerve The capsule of the tumour is incised with the diathermy needle and the interior of the tumour is aspirated or removed by means of a small metal loop The capsule is then gradually removed by careful traction Hæmorrhage may be controlled by means of small rolls of cotton wool and a gentle stream of hot saline solution

Cystic stalk tumours are exposed in a similar way The cyst is punctured the fluid withdrawn and the capsule removed by firm traction The closure of the wound after a transfrontal operation is quite simple The bone flap is replaced the periosteum sutured and the scalp returned and sutured with interrupted silk worm gut sutures

In some retrochiasmal tumours a scotoma may occur

This may be performed by making an opening in the manner described for exposing the middle meningeal artery and enlarging it by means of bone nibbling forceps or four

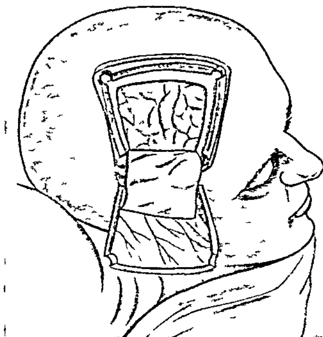


Fig 232 —Decompression operation

Osteoplastic flap turned down The dura has been incised, exposing the brain

small burr holes can be made and the bone removed in the manner described above (Fig 231)

The base of the osteoplastic flap is its narrowest part and can be easily broken through by an elevator applied to the broad upper margin of the flap The dura mater is also incised and turned down in the form of a flap (Fig 232)

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In some retrochiasmal tumours a scotoma may occur

Fig 233.—Transfrontal approach to a pituitary tumour
(The insets show the method of forming the osteoplastic flap)



Fig 234.—Relation of optic chiasma to the pituitary fossa

instead of a hemianopic field defect—more especially in hypophyseal duct tumours

As the majority of pituitary tumours arise below and rather in front of the chiasma they cannot cause a scotoma unless the chiasma occupies a prefixed position (Fig 234), which it does in about 5 per cent of cases When, however the chiasma is prefixed a pituitary adenoma usually extends upwards behind it and commonly produces central scotomata

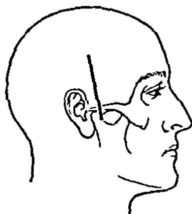


Fig 235 —Incision used for section of the sensory root of the fifth cranial nerve

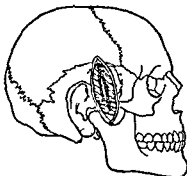


Fig 236 —The incision in the temporal muscle and the opening in the skull required for section of the sensory root of the fifth cranial nerve

V Section of the Sensory Root of the Fifth Cranial Nerve

Indications —The main indication for this operation is of course tic douloureux or trigeminal neuralgia It is occasionally performed in cases of carcinoma of the anterior part of the tongue or floor of the mouth and in the intractable pain caused by radium burns There is some reason to believe that increased use of teleradium, with its severe after pain may necessitate routine root section In expert hands the mortality is surprisingly low

Anæsthesia —Many surgeons perform the operation

under local infiltration and scopolamine alone because of the enfeebled condition of their patients However endotracheal gas oxygen and ether are relatively safe Local infiltration is also used because of its hæmostatic qualities

Position —The possession of a special table where the sitting position with a forehead and chin rest can be used

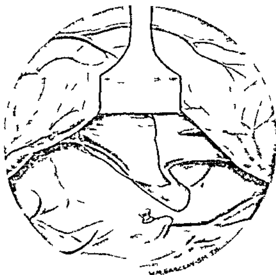


Fig 237 —Exposure of the Gasserian ganglion

The visceral layer of dura mater has been raised The ligatured middle meningeal artery can be seen at the foramen spinosum

is invaluable Any oozing will then drain away from the operation site and not obscure the perfect vision which is essential A good head light is essential

Method —This is well shown in the diagrams and little remains but to comment upon them

Fig 235 —The incision is carried down to the fascia over the temporalis muscle and towels are applied

Fig 236 —The temporalis is split vigorously retracted

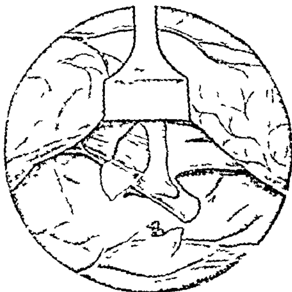


Fig 238 —Exposure of the sensory root

A small flap of arachnoid has been raised up exposing the fan shaped sensory root.

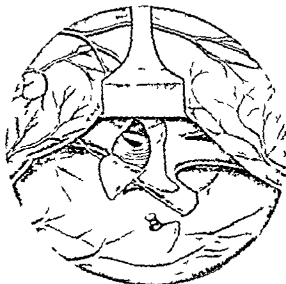


Fig 239 —Exposure of the sensory root

The fibres of the sensory root have been drawn outwards thus exposing the motor root which is on its deep aspect

and the bone exposed. A large burr hole is made and the opening enlarged with rongeurs to correspond with the circle dotted on the diagram. Care must be taken when enlarging in a backward direction as occasionally the mastoid air-cells *come forward into the zygoma and these are potentially* infected. The dura mater is elevated from the floor of the skull and the middle meningeal artery coagulated in the foramen spinosum.

Fig 237 —The ganglion is now seen and the parietal dura mater incised over it. This leads back to the sensory root

Fig 238 —The arachnoid sheath is then incised and the fan shaped fibres of the sensory root are exposed.

Fig 239 —With a blunt hook the root is drawn gently outwards and the motor root allowed to fall away As much of the sensory root as is desired may then be divided It is usual to spare the upper tenth to preserve some corneal sensation Of course if there is neuralgia in the first division as well then the whole root is divided. The dura mater is allowed to fall into place the brain expands readily and the incision is closed accurately in layers There is no special after treatment except to protect the cornea for a week.

VI Intramedullary Tractotomy

By means of a cerebellar approach Sjogvist in 1938 devised an operation in which he was able to divide the pain fibres in the descending limb of the trigeminal tract by an incision through the posterolateral aspect of the medulla oblongata (Fig 240) and spare the sensation of touch so that the face did not remain unpleasantly numb Reported cases in this country prove the value of this operation

The advantages of the operation are that the face is not denervated completely analgesia is greatest in the forehead and the muscles of mastication are never paralysed a very important consideration in bilateral cases Moreover the great superficial petrosal nerve is far from the site of operation and therefore the danger of a dry eye is avoided

VII VENTRICULOGRAPHY

This operation consists in replacing the cerebro spinal fluid in the ventricular system by some contrast medium in

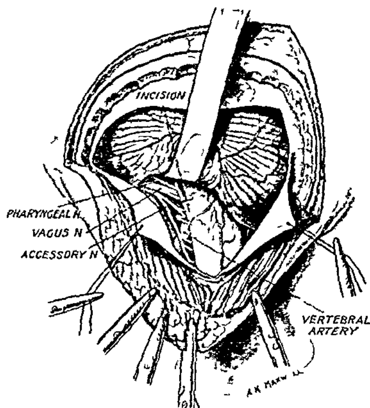


Fig 240 —Operation view showing the site for intramedullary tractotomy

order to obtain skiagrams revealing the position, size, shape filling defects or otherwise of the ventricles Air is by far the safest contrast medium to use though on rare occasions thorotrast may be preferable

and the bone exposed A large burr hole is made and the opening enlarged with rongeurs to correspond with the circle dotted on the diagram Care must be taken when enlarging in a backward direction, as occasionally the mastoid air-cells come forward into the zygoma and these are potentially infected The dura mater is elevated from the floor of the skull and the middle meningeal artery coagulated in the foramen spinosum

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to use the prone position and then turn the head to one side when the ventricles have been entered

Procedure —The head has previously been shaved and purified The sites for incision are chosen about 4 cm on either side of the mid line and 7 cm above the external occipital protuberance (Fig 241) The scalp is infiltrated with novocain and a 1½ inch incision is made parallel to the line of the scalp vessels A medium size burr hole is made and the dura mater inspected A minute cruciate incision is made at a spot where no underlying cortical vessels

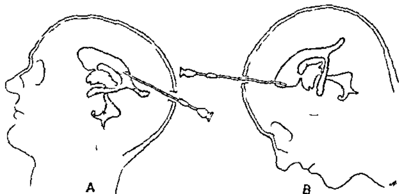


Fig 241 —Ventriculography
A —Posterior approach B —Anterior approach

appear The special ventriculography needles are then entered in a direction designed to enter the junction of the posterior and descending horns with the body This is best done in the following manner The surgeon places his left index finger on the nasion and then directs the needle from the burr hole towards the finger on the nasion This direction is forwards and slightly inwards (Fig 241) The entrance to the ventricle is appreciated by a sudden absence of normal resistance and the escape of cerebro spinal fluid on withdrawing the obturator in the needle It is preferable though not always convenient or essential to tap both ventricles The cerebro spinal fluid is now allowed to escape from the

Warnings.—The operation should not be done unless the surgeon is ready to proceed if necessary with an exploratory craniotomy It is customary in many clinics to perform the ventriculography in the morning study the wet films and proceed in the afternoon with the major operation

If the ventricles are not readily entered by the needle not more than three attempts should be made

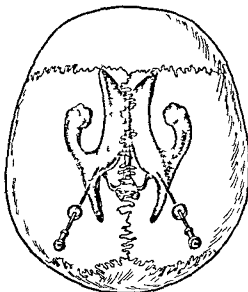


Fig 241.—The ventricular cavities of the brain viewed from above showing the sites for the burr holes for ventriculography and the direction of the needles with the optimum site for entrance of the ventricles

Anæsthesia.—Local anæsthesia is quite sufficient and the co-operation of the patient is helpful With this in view, basal narcotics are best withheld

Position.—There are various positions in vogue but the one most commonly used is the semi sitting position with the neck well supported and flexed Some surgeons prefer

Steps of the operation—The meatus is syringed out and cleaned as far as possible, the external ear and skin over the mastoid process are disinfected The adjacent scalp should have been shaved, and the head enveloped in a sterilized towel over a waterproof cap The auricle being held forward by an assistant, the surgeon makes a slightly curved incision downwards from the supramastoid ridge

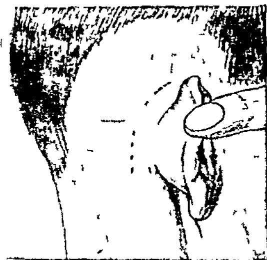


Fig 244.—The posterior incision is the one used *in exposing the mastoid antrum* The small anterior incision is used for removing foreign bodies from the bony meatus the auricle being *drawn forwards*

towards the apex of the mastoid process parallel to the posterior wall of the meatus (Fig 244) A small transverse incision is usually required near the upper end of the main one The knife goes right down to the bone, with due care not to penetrate it in the case of a child's thinned mastoid process With a rugine the soft parts are peeled backwards and forwards until an area corresponding to the dotted line (Fig 245) is exposed the skin edges and periosteum being

ventricles by gravity and air allowed to flow in Alternatively, air may be introduced by a syringe after withdrawal of equiva lent amounts of cerebro spinal fluid The incision is closed with a few sutures which also secure the scalp vessels The patient is then ready for the radiologist

Sometimes it may be necessary to tap the anterior part of the main ventricular cavity and introduce air from this approach (Fig 242 B)

Difficulties —As ventriculography is naturally reserved for abnormal cases many difficulties may be encountered It may be difficult or impossible to enter the ventricles

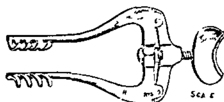


Fig 243 —Self retaining mastoid retractor

A cyst may be entered by mistake for the ventricles this, however is diagnosed readily on taking skiagrams The ventricles may be markedly displaced or collapsed As much air as possible is introduced as sharper contrast is thus ob tained The third and fourth ventricles are filled by tilting the head appropriately

VIII Exposure of the Mastoid Antrum

Instruments required —The best instrument for open ing the antrum is a sharp steel gouge with a handle ending in a broad round knob Two gouges one about 5 mm wide in cutting edge the other about 10 mm a metal mallet fine flexible probe curettes Volkmann s scoops a syringe and Stacke s protector should be at hand besides the usual cutting and hæmostatic instruments and self retaining mastoid retractor (Fig 243)

Gentle syringing with weak antiseptic lotions should be employed daily, followed by gauze dressing When all purulent discharge has ceased, the opening may be allowed to close

VI THE COMPLETE OR RADICAL *MASTOID OPERATION*

In certain cases of long persisting otorrhœa with marked loss of hearing, an operation is performed which involves

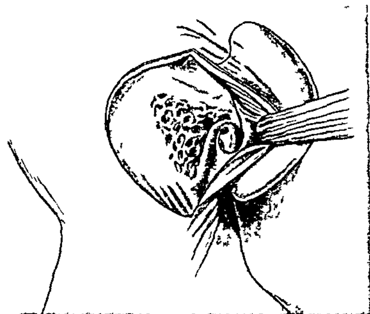


Fig 246 —The radical mastoid operation complete
The promontory and labyrinthine wall of the tympanum can be seen

removal of the remains of the membrana tympani, the small bones of the ear and the posterior wall of the meatus, so as to convert the tympanum and the mastoid antrum into one cavity This is lined either by flaps from the soft tissues of the meatus or by epithelial grafts (Fig 246)

Operation—The patient having been prepared and the head shaved as described on p 523 a curved incision

held in place by a self retaining mastoid retractor The bone enclosed within this line is then gouged away bit by bit

The instrument is directed forwards and inwards parallel with the long axis of the meatus It is convenient to introduce a short piece of gum elastic catheter into the meatus as a guide and to keep the gouge exactly parallel with it



Fig 245.—External surface of petrous bone

E A External auditory meatus s styloid process S.M rough surface of attachment of sterno mastoid muscle The supramastoid crest of bone is continued back to P the postero inferior angle of parietal bone V mastoid foramen giving exit to a vein M dotted circle indicating area cut through in trephining the mastoid antrum M' area of bone removed in the complete mastoid or radical operation

If the instrument be directed inwards at right angles to the surface of the skull at the point indicated the antrum will certainly be missed and the lateral sinus almost as certainly opened The direction followed by the gouge is therefore of the utmost importance

In the adult the antrum will be *reached at a depth of* about half an inch The loss of resistance and the escape of pus indicate when the cavity is opened

The opening is enlarged to the desired extent by means of the sharp gouge If any necrosis be present the gouge will need to be liberally employed

The tunnel in the bone having been well syringed out a suitable drainage tube is inserted

pinna, which, being turned back and held in position ultimately becomes the outer wall of the antral cavity A thin bladed bistoury is inserted through the fibrous meatus and made to cut upwards and outwards from the upper end it is now withdrawn and made to cut downwards and outwards from the lower end By this means a quadrilateral flap is made of the posterior part of the pinna which is turned backwards and fixed to the raw surface of the pinna with one or two catgut sutures Or a simple and rather more satisfactory method may be employed A Y shaped incision is made with the open arms directed backwards, in this way three small flaps to cover the upper, lower and posterior walls are formed The pinna is now sewn back with silkworm gut sutures, the common cavity of the tympanum and antrum being plugged with gauze from the meatal opening This gauze is left in position for three to four days, the cavity then being syringed and plugged daily

Comment on the operation—In the radical mastoid operation the chances of success depend to a large degree upon the after treatment The cavity requires careful and accurate plugging and syringing so as to prevent adhesions from forming between the granulations on either side At the same time any granulation tissue must be carefully removed so that in time the wall will become covered with epithelium spreading from the flaps This usually occupies about three months In many cases it may be impossible to remove every portion of necrotic bone Even small portions of this will cause a granulating area lasting for a considerable time which will be shown by a long continued but slight otorrhœa The operation of skin grafting was introduced with the idea of shortening the convalescent period If there be the smallest area of necrotic bone the graft will break down over it leaving a granulating area and in many such cases it has been found necessary to repeat the grafting five or six *times* If the wall be perfectly clean and aseptic the graft will probably take but here it is unnecessary for if flaps be made as above described the cavity will become *covered* by epithelium almost as rapidly The necessity of performing

is made down to the bone The attachments of the pinna behind are now separated from the bony wall by a *periosteal elevator and the whole pinna pulled forwards* u itil the opening of the bony meatus is well seen The antrum is now opened the outer wall being removed by a gouge or chi el The cavity having been well opened the extent of the disease is determined and any granulations or carious bone removed Two openings are now present—that of the bony external meatus in front, and the artificial open ing into the antrum behind They are separated by the pos terior wall of the auditory canal. The outer part of this ridge is removed with the chisel, any remains of the mem brana tympani usually coming away with it In performing this step care should be exercised to remove the bone in small pieces

The pinna is now pulled forwards by a suture or piece of gauze pressed through the fibrous meatus The tympanic cavity is thus exposed any remaining portion of the mem brane necrotic remains of the ossicles or granulations being curetted away During these stages the cavity of the antrum and middle ear should be kept quite dry by swabbing with mastoid strips A probe or Stacke s guide is now passed through the aditus so that the extent of the remaining bridge *of bone may be accurately determined* This *piece* of bone must be carefully removed with the chisel It is at this stage that danger is likely to accrue to the facial nerve which lies beneath the external semicircular canal on the floor of the aditus It may be best protected by leaving the bent probe lying in the aditus while the outer wall is removed The walls of the cavity are now smoothed down with the chisel and burr At the end of the operation the upper level of the antrum the attic and the aditus should lie in a straight line the enlargement of the aditus being mainly brought about by removing its upper wall whereby the facial nerve is in no danger of being injured All recesses are now curetted the whole cavity being left as smooth as possible to expedite healing

The next step is the formation of a skin flap from the

subjects especially this may prove impossible. It is useful in doubtful cases to expose the wall of the sinus, and to judge by inspection or by aspiration with a fine needle, whether the contents are normal or not. It may be noted that the lateral sinus as a rule lies in a deeper groove on the right side than on the left.

Steps of the operation.—Supposing that in a case of suppuration in the middle ear repeated rigors with local

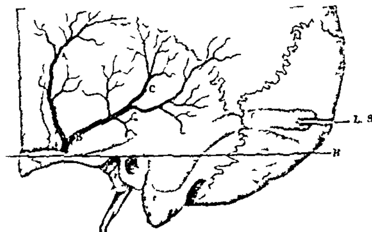


Fig 247.—Showing relationship of the lateral sinus to Reid's base line and position of the branches of the middle meningeal artery

R Reid's base line L S lateral sinus A anterior branch of the middle meningeal artery, 1¼ inches behind the fronto malar point and 1¼ inches above Reid's line B posterior branch origin 1½ inches behind the fronto malar point and ½ inch above Reid's line C posterior branch in its posterior part 1 inch above the external auditory meatus

symptoms have made it certain that there is thrombosis the internal jugular vein should be exposed in the upper part of the neck by an incision over the anterior border of the sterno mastoid muscle Care should be taken to avoid the descendens noni and pneumogastric nerves The vein should be isolated after its sheath has been opened for an inch of its course and a catgut ligature is put round it after which the

a second operation is also a great drawback. Not only does the patient object to undergoing it when he feels in perfect health but by this procedure the time necessary to lie up is greatly increased—a matter of no small moment to the majority of patients

VII OPERATION FOR THROMBOSIS OF THE LATERAL SINUS

The indication for operation is thrombosis by extension from suppuration in the middle ear This condition, the distinguishing *feature of which is the occurrence of rigors* is best met by trephining over and opening the lateral sinus and washing out the septic clot through an opening lower down in the jugular vein By this means many cases have been saved from impending death from pyæmia

Landmarks for the operation—The lateral sinus passes from the inner side of the occipital protuberance forwards and slightly upwards to the postero inferior angle of the parietal bone If the ridge on the mastoid process be followed upwards it is found to end in a depression which *corresponds to the genu of the lateral sinus from which* the latter bends downwards and inwards deeply excavating the petrous bone The sinus leaves the base of the skull just internally to the styloid process and in front of the transverse process of the atlas The beginning of the jugular vein is thus inaccessible to the surgeon being placed so deeply and if necessary the vein should be exposed lower down below the parotid gland on a level with the thyroid cartilage or hyoid bone As it grooves the skull the most accessible part and that in which thrombosis from ear disease usually occurs is the genu and the next inch of the descending portion. If a line be drawn backwards from the lower border of the nostril through the middle of the external auditory meatus and the pin of the trephine be placed on this line 1½ inches behind the centre of the meatus it will be directly over the lateral sinus The relationship of the lateral sinus to Reid s line is shown in Fig 247 It is quite possible in some cases by trephining very carefully to lift off the bone from the wall of the sinus without damaging the latter but in old

CHAPTER II

EXCISION OF THE EYEBALL

Instruments required.—Eye speculum strabismus hook, strabismus scissors, toothed forceps, blunt edged scissors curved on the flat small sponges.

Operation—The patient's head is a little raised, and the surgeon stands in front facing the patient

The speculum is introduced between the lids and opened

With the blunt-pointed scissors the surgeon snips through the conjunctiva just behind the corneal margin The toothed forceps are used to pick up the membrane and to steady the globe The division of the conjunctiva is completed all round

By the further use of the scissors Tenon's capsule is freely opened and each of the rectus tendons is then picked up in turn with the strabismus hook and is divided close to the sclerotic with the strabismus scissors It is convenient to begin with the external rectus then to divide the superior and inferior recti and to finish with the inner rectus If the speculum be now pressed back into the cavity of the orbit the eyeball starts forwards The blunt ended scissors curved on the flat are then introduced into the orbit on the outer side of the globe and are carried back until the optic nerve is reached It is divided by one cut of the blades

The eyeball being drawn forwards with the fingers the oblique muscles are divided together with any soft parts which may still hold the globe in place

A piece of Turkey sponge is then pressed into the cavity of the orbit and is allowed to remain there for a few minutes

vein is clamped above and divided The lateral sinus is then exposed by means of a one inch trephine the pin of which is inserted at the point already mentioned The sinus is opened after its wall has been further exposed by cutting forceps working in the downward direction All septic clot is then removed by means of a scoop small pieces of sponge and irrigation. If the clot has extended backwards along the horizontal portion it should be removed and the surgeon should only be satisfied when healthy blood flows out of the upper end of the sinus and a clear current of antiseptic solution can be syringed through the severed jugular vein, from which the clamp has been removed Hæmorrhage from the upper end will be stopped by plugging with antiseptic gauze and a second catgut ligature should be placed on the divided vein.

As the diagnosis of lateral sinus thrombosis is not easy it will usually be preferable in cases where the symptoms are at all indefinite to enlarge the opening into the mastoid antrum backwards until the lateral sinus is laid bare Any pus around the sheath of this is then removed and the condition of the interior of the sinus determined by passing a small hypodermic needle This may however be misleading as the thrombosis always starts around the walls of the sinus (mural thrombosis) and the needle may therefore be pushed through the clot and into the fluid blood with patent lumen of the vessel If fluid blood be found but little harm will have been done as it is unlikely that infection will have been carried along the needle track and no bleeding will take place from the small puncture If on the other hand the sinus be found to be thrombosed this wound is covered up the internal jugular vein isolated in the neck, and the operation continued as above

CHAPTER III

CISTERNAL PUNCTURE LUMBAR PUNCTURE AND LAMINECTOMY

Cisternal puncture —This is a *useful* procedure and is carried out when lipiodol is injected into the subarachnoid space in case of suspected spinal tumour or other spinal obstruction. An examination of the cerebro spinal fluid below the level of the lesion is of the utmost importance in such cases, yellow-coloured fluid (xanthochromine) with a high percentage of albumen and increased globulin is pathognomonic of tumour of the spinal cord Examination of the pressure of the fluid above and below the lesion is also of great assistance manometers introduced by cisternal and lumbar punctures should show similar variations in pressure on compression of the jugular veins coughing etc if however there is a spinal block, the variations in pressure will differ (Queckenstedt)

The actual operation is simple but the surgeon *must not* push the needle in too far or the medulla may be injured

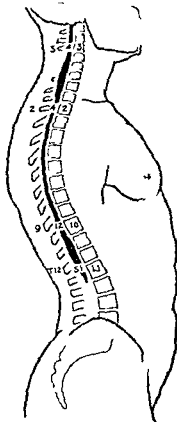


Fig 248 —Relation of spinal cord to the vertebral column The cord ends at the lower border of the first lumbar vertebra

If the globe be collapsed as is frequently the case when excision is carried out the operation becomes a very meagre affair scarcely removed from the humble procedure of detaching a slough with scissors and forceps

It is well in these cases however to take care to remove the globe alone and to leave the muscles with as little of their substance displaced as possible.

solution of lipiodol introduced through a lumbar puncture needle may help to localize exactly the situation of a spinal tumour Further information concerning the site and extent of such a tumour may be obtained by the introduction of a heavy lipiodol solution through a cistern puncture

Lumbar puncture may be an exceedingly dangerous procedure in cases where a brain abscess is present If such

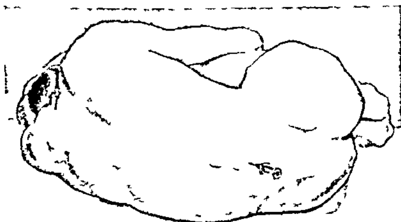


Fig 250 —Lumbar puncture showing flexed position of the patient

a condition is suspected lumbar puncture may only be carried out with the patient fully prepared upon the operating table and even then only the minimal quantity of cerebro spinal fluid required for diagnostic purposes must be withdrawn

When employed as a means of treatment in cases of menin gitis and intracranial suppuration it may be carried out daily, or twice daily until the cerebro spinal fluid becomes clear and the pressure falls to within normal limits (100–150 mm of fluid) Various drugs sera and anti substances have been introduced into the theca as a thera peutic measure but results have shown little to justify this method of treatment

A line joining the tips of the mastoid processes passes through the centre of the posterior atlanto occipital membrane Under local anæsthesia a lumbar puncture needle is entered just to one side of the middle line and passed upwards and forwards *until the thickened membrane is slowly pierced* and cerebro-spinal fluid is obtained (Fig 249)

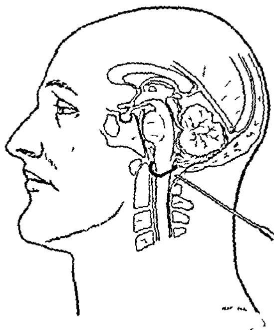


Fig 249 —Cisternal puncture The dark ring is the outline of the mastoid process

Lumbar puncture —This simple operation may be performed for the purposes of diagnosis treatment or for obtaining anæsthesia at any level below the nipples An examination of the fluid so withdrawn may yield valuable information in cases of intracranial suppuration and cerebral tumour and the replacement of some of the cerebro spinal fluid by a light

Advantages of Spinal Anæsthetics —

(1) They may be given by a surgeon when the services of a competent anæsthetist are not available

(2) They give complete relaxation of the abdominal muscles, thus making the use of a retractor unnecessary, unless it is desired thereby to find a safe and permanent resting place for the careless hands of the casual assistant

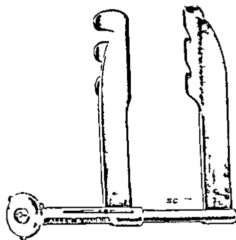


Fig 251 —Wakeley s laminectomy retractor

(3) They are less likely to be followed by pulmonary complications

(4) They are often particularly useful in cases of intestinal obstruction in which great difficulty is often encountered in closing the abdominal wound

One serious danger should be remembered in connexion with this type of case A wave of peristalsis is set up by the action of spinal anæsthetic and may cause the whole of the contents of the small intestine to return through the

The patient is placed in the left-lateral position with the spine fully flexed and with the head approaching the knees as completely as circumstances will permit. The lumbar and sacral regions are exposed and a line joining the highest points of the iliac crests crosses the spine of the 4th lumbar vertebra (Fig. 250). After purification of the skin, a little local anæsthetic is injected either above or below the 4th spinous process a quarter of an inch from the mid line. A lumbar puncture needle containing an accurately fitting stilet *is directed inwards and slightly upwards for a distance of* 2 to 3 inches penetrating the sacro spinalis muscle the liga menta sub flava and the theca. A satisfactory puncture is shown by the steady flow of cerebro spinal fluid at the rate of 1 to 2 drops per second on the withdrawal of the stilet. Should a dry tap be obtained the needle must be withdrawn to the skin level and inserted again at a slightly different angle. If three such attempts fail the operation should be abandoned as the cause of failure is in all probability advanced osteoarthritis of the spine preventing adequate flexion and separation of the laminæ.

Spinal anæsthesia.—It is now possible to obtain complete abdominal anæsthesia by the introduction of an anæsthetic solution having a specific gravity less than that of the cerebro spinal fluid and of such dilution as to be rela tively non toxic. Such a solution is percaine 1 in 1 500 and after its introduction into the spinal theca the patient is *placed face downwards with the foot of the table raised* for a period of 6 minutes. The percaine is thereby kept in con tact with the posterior nerve roots in the lower part of the spinal theca and at the end of this time he may be transferred to the theatre, placed upon his back and the head of the table lowered and producing 15 degrees of tilt, after which the operation may be commenced with safety. If doubt is felt as to whether the anæsthetic has been effective do not pinch the skin and ask Do you feel that? The man is not yet born who can resist the temptation to say Yes. Simply ask him to cough and observe the reaction of the abdominal muscles if they remain flaccid then the anæsthetic has done its work.

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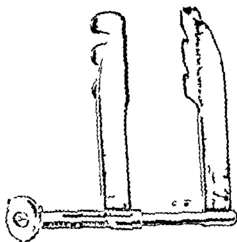


Fig 251 —Wakeley's laminectomy retractor

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One serious danger should be remembered in connexion with this type of case A wave of peristalsis is set up by the action of spinal anæsthetic and may cause the whole of the contents of the small intestine to return through the

mouth in a putrid and persistent stream in which the patient drowns

Any spinal anæsthetic is always associated with a fall in blood pressure, and it should not be employed in cases in which the blood pressure is abnormally low

It is a measure which yields valuable information concerning the suitability or otherwise of certain cases for

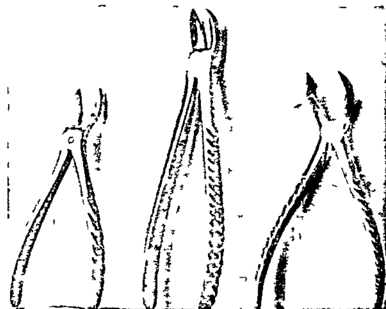


Fig 252 —Forceps for dividing laminæ and spinous processes

the operation of sympathectomy for the administration of spinal anæsthetic produces for the time being the result which a sympathectomy may be expected to produce permanently It is therefore of value in estimating the probable success or failure of sympathectomy in cases of Hirschsprung s disease and vaso motor disturbances of the lower limb

LAMINECTOMY

Indications.—This operation is indicated in the following conditions

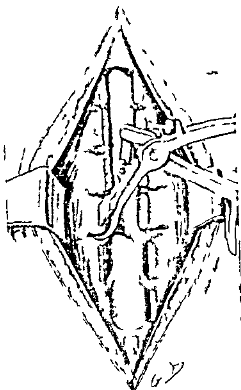


Fig. 253.—Laminectomy: method of widening groove in laminæ with guillotine forceps.

To relieve pain.

1. From injuries

(a) Gunshot wound foreign bodies etc
(b) Fractures and dislocations of the spine

2 From inflammation involving brain meninges or cord due to
(a) Pyogenic organisms
(b) Syphilis
(c) Tuberculosis

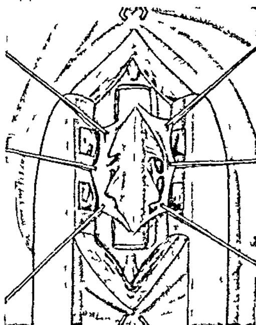


Fig 254 —Laminectomy for the removal of a spinal tumour

The dura mater has been incised

3 From new growths
(a) Benign
(b) Malignant

Treatment for relief of pain

1 By division of the posterior nerve root.

2 By antero lateral cordotomy
3 By posterior cordotomy

The operation is called for *urgently* when a foreign body is lodged in the spinal canal or when an open wound exists, and *early* when an X ray shows compression of the cord to be

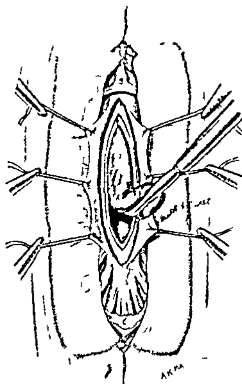


Fig 255 —Removal of intra medullary tumour

due to a displaced fragment of bone In all other cases operation may be delayed and deliberately planned after full preliminary investigation

Instruments —Scalpels artery forceps, Wakeley s laminectomy retractor (Fig 251) laminectomy forceps sharp

chisel ¾-inch trephine, dural elevator, rongeur forceps (guillotine type)

Operation —The most suitable anæsthetic is intra tracheal gas, oxygen and ether The patient lies prone, and sandbags are placed in such a way as to bring the spinous processes as close to the surface as possible A vertical mid

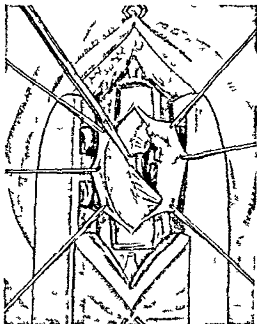


Fig 256 —Laminectomy for the removal of a spinal tumour
The ligamentum denticulatum and a spinal nerve root have been cut so as to expose the tumour on the anterior surface of the cord

line incision 8 inches long is made with its centre over the site of the lesion The wound is deepened until the spinous processes are exposed and the erector spinæ muscles are separated from the spines by means of a scalpel Bleeding is controlled by tightly packing the wound with large swabs wrung out of very hot saline The muscles are elevated from

the laminæ by a broad sharp chisel used in the manner of a periosteal elevator and hæmostasis is again secured A special retractor (Fig 251) now gives a clear exposure of five laminæ, two above and two below the level which is to be investigated

The spinous processes are removed with laminectomy forceps (Fig 252), and the lowest lamina is trephined, allowing access to the cutting forceps with which the remaining laminæ are divided Special forceps devised by Hudson are ideal for removing the overhanging ledge of bone on either

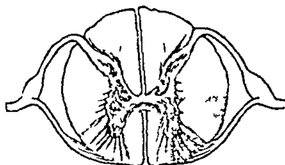


Fig 257 —Chordotomy

The dotted area includes the amount of tissue incised by the knife

side so giving full exposure of the cord in its membranes The cord is examined for pulsation and the dura mater opened at a point well removed from the site of the suspected lesion (Fig 253) The subsequent procedure will depend upon the nature of the findings displaced fragments of bone or foreign bodies will be removed constricting bands divided granulation tissue curetted away and tumours innocent or malignant, dealt with as the occasion demands (Fig 255) Occasionally it may be felt that the removal of an intra medullary tumour in one stage may prove too severe a test of the patient s strength, and it may be left to extrude itself through the space operation has provided in the bony spine a process which will occur in the course of a few days

The anterior surface of the cord may be exposed and

inspected by using the dentate ligament as a tractor with which to rotate the cord (Fig 256) When thus rotated the *antero lateral tracts can be divided with a specially guarded* knife, thus dividing pain fibres arising in the opposite side *of the body (Fig 257) Attempts have also been made* to obtain this result by dividing these fibres as they cross to the opposite side at a level considerably higher than their entrance to the cord This necessitates a complete median longitudinal section through the whole thickness of the cord

At the completion of the operation the incision into the dura may be closed by means of fine interrupted catgut sutures and the muscle masses are drawn together by strong interrupted stitches Lastly, the fascia is reconstructed and the skin closed No drainage is inserted unless there is an inflammatory focus

Spina Bifida

Simple meningoceles in babies which show no evidence of nerve involvement e g paralysis or club foot are the *only favourable cases for operation* There must be sufficient healthy skin to cover the wound without tension at the con clusion of the operat on The sac is dissected down to the level of the laminæ where it is ligatured with fine catgut and excised after which the wound is closed in layers without drainage

For some reason which is not yet understood hydro cephalus develops in a very high percentage of even the most favourable and carefully selected cases

PART XIV—OPERATIONS ON THE BREAST

Excision of the Breast

Instruments required.—Several large and small scal pels If one knife is used for cutting into the tumour it should be at once laid aside and another taken Dissecting and sharp pointed forceps Wells s pressure forceps two pairs of scissors aneurysm needle (occasionally wanted) volsella forceps blunt dissector needles, sutures and needle holder etc

Position.—The patient is brought to the edge of the table and lies with the head and shoulders raised The arm of the affected side is well raised from the side and held away from the trunk by an assistant Another assistant attends to the sponging

The axilla has been thoroughly shaved and disinfected beforehand The arm neck and abdomen are protected by mackintosh sheeting over which sterilized towels are placed

Operation—The exact incision made will vary accord ing to the individual case though its general form will be elliptical with the growth in the centre (Fig 258) The upper end of the incision used to be made through the centre of the axilla but it is much better to place it well over the border of the pectoralis major muscle tailing slightly down wards across the insertion of the latter The reasons for this are (1) The axillary skin is provided with large hair bulbs and modified sweat glands It is practically impossible to render these aseptic and hence the wound should not be made through this region of skin (2) In all cases it is best to remove with the breast the costal or lower portion of the great pectoral muscle and this is rendered

inspected by using the dentate ligament as a *tractor* with which to rotate the cord (Fig 256) When thus rotated the antero lateral tracts can be divided with a specially guarded knife, thus dividing pain fibres arising in the opposite side of the body (Fig 257) Attempts have also been made to obtain this result by dividing these fibres as they cross to the opposite side at a level considerably higher than their entrance to the cord This necessitates a complete median longitudinal section through the whole thickness of the cord

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tissues only and should just pass down into the subcutaneous fat The reflected flap has exposed the pectoralis major near its insertion and has uncovered the outer part of the axilla The upper or pectoral incision is now made and reflected in the same way as far upwards as the clavicle and inwards to the sternum The skin flaps are widely undercut in order that all the subcutaneous lymphatics and the maximum amount of deep fascia, which is also rich in lymphatic vessels, shall be removed together with the breast and pectoral muscles (Fig 258)

The chief assistant, who stands on the opposite side of the table draws up the skin on the sternal side of the mamma towards the median line while the surgeon lightly presses the breast downwards with his left hand While the parts are in this position the upper limb of the incision is carried down to the pectoral muscle If the skin be fully retracted by the assistant a division of the deeper parts well beyond the limits of the breast is ensured

The surgeon grasps the mamma and draws it away from the thorax while he severs its deep attachments in such a way as to lay bare the great pectoral muscle The origin of this muscle is now cut across In dividing the muscle close to its origin from the sternum and costal cartilages the anterior perforating vessels must not be cut too close to their points of emergence As a rule they can be secured by pressure forceps before being cut across An artery will be found coming through each intercostal space

The breast with the underlying muscle is now drawn downwards and outwards and the humeral insertion divided cautiously so as to expose the axillary vessels the incision being made at right angles to the fibres With ordinary care there is no risk of damaging the axillary vein as a layer of fascia and some fat separate the muscle from it

Removal of the pectoralis minor does not interfere with the subsequent use of the arm, and it certainly renders exposure of the axillary vein more easy Glands and fatty tissue are carefully dissected off the vein, from under the clavicle downwards The vein is left as bare as possible

easy by this modification of the old incision (3) Clearing the axilla especially the upper part of it between the clavicle and first rib is done by open dissection through this incision By the midaxillary one this step was effected mainly by finger traction in the dark, with increased risk of venous hæmorrhage

In dealing with the right side the surgeon commences the incision over the axilla and cuts towards the chest

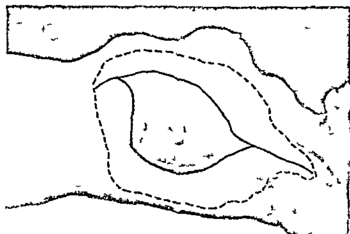


Fig 258 —Excision of the breast showing the incision (dark line) and the amount of undercutting required to remove all the subcutaneous fat with the lymphatics (dotted line)

In dealing with the left breast it is convenient to commence the incision at its lower part and cut towards the axilla

In either case the lower or axillary half of the incision is made first for convenience as to the bleeding The flap is retracted by careful dissection until the posterior fold of the axilla (edge of the latissimus dorsi) is reached and the muscle well exposed The lower part of the incision should come as far as the epigastric angle

The knife should at first involve the skin and superficial

axillary vessels to the lymphatic glands will necessarily be divided, and all such vessels should be clamped before their section

Careful search should be made for the lymphatic glands which lie close to the coracoid process and first rib, and they should be removed whether apparently infected or not

It is now convenient to mention the following *general points* with regard to excision of the breast (1) All bleeding points should be picked up neatly, and not grabbed up together with a mass of the surrounding tissue (2) The sponging should be done with a light hand (3) The whole contents of the axilla should be removed in one mass with the breast leaving the serratus magnus the subscapularis and latissimus practically bare (with due regard to the integrity of the nerves to these muscles)

The skin incision should be at least 5 inches in diameter, taking the malignant tumour as its centre and not the nipple

The bleeding points are now dealt with In the majority of cases the long continued pressure of the forceps will suffice to close the larger number of the vessels, others are occluded by twisting the pressure forceps when they are removed But as recurrent hæmorrhage is more common after excision of the breast than after any other operation it is best to tie every doubtful vessel with catgut or to coagulate it with the diathermy When this has been done and the cavity flushed with hot sterile water the long wound is sewn up Owing to the way in which the flaps have been undermined it is usually practicable to bring them together without undue tension But if the skin has been too extensively removed to allow this throughout the whole length of the wound a raw surface must be left which may need subsequent grafting

In order to bring the edges together it is well to place a few guide sutures at long intervals these need not be tied, but held by Wells's forceps The intervals between these are then sewn up with interrupted sutures of silkworm gut The assistant follows the closing wound with sponges so applied as to maintain considerable pressure over the recently

Many surgeons prefer to commence the removal of the breast from the insertions of the pectoralis major and pectoralis minor muscles and to clear the axilla thoroughly before separating the breast and the pectoral muscles from the chest wall

In completing the removal of the breast and axillary contents the serratus magnus the subscapularis the axillary vessels and nerves will be laid bare (Fig 259) Now and then

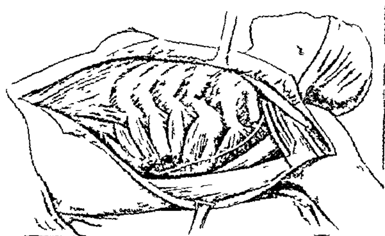


Fig 259 —Radical amputation of the breast

The axillary vessels can be seen also the nerve of Bell lying on the serratus magnus muscle The breast and pectoral muscles and axillary glands have been removed

it may be necessary to excise part of the axillary vein between two ligatures in order to get away adherent glands This should be avoided if possible as the cephalic vein may be deficient and œdema of the arm is then apt to follow

The intercosto humeral nerve will usually require to be divided leading to subsequent numbness at the lower and inner part of the arm but the subscapular nerves the corresponding artery and vein and above all the long thoracic nerve should be spared Branches of the subscapular and

For a tumour situated in the lower quadrant of the breast a sub-mammary incision may be used (Fig 260) It has the advantage that the scar is invisible

Intracystic duct papilloma of the breast can be excised

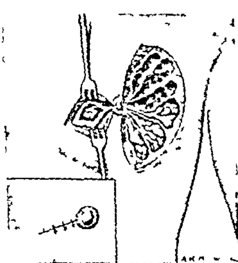


Fig 261 —Excision of single intra cystic duct papilloma of the breast

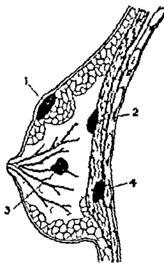


Fig 262 —Diagram showing position of breast abscesses

1 Supramammary
2 Submammary
3 Intramammary
4 Retromammary

by a small radial incision the cyst is opened and the papilloma removed (Fig 261)

Abscess of the Breast —The four varieties of abscess of the breast are depicted in Fig 262 In the supramammary variety it matters little in which direction the incision is made to evacuate the pus since the pus is always superficial to the breast tissue

For the true intramammary abscess the incisions should radiate from the nipple

united incision and to obliterate the wound cavity This pressure must not be relaxed In all cases it is advisable that an opening for a drainage tube should be made in the hollow of the skin below the wound A tube is inserted and secured by a suture

The middle sutures—i e those in the central part of the wound—are now inserted and when they are all in place, tied The assistant with the sponges still follows the sutured incision and obliterates by pressure the wound cavity The dressing is prepared. It consists of a large pad of sterilized *gauze or dry cyanide gauze over which sterilized wool is used* The wool covers the whole side of the chest, the opposite breast the shoulder and the back as far as the spine

TREATMENT OF INNOCENT TUMOURS OF THE BREAST

Innocent tumours of the breast may be removed by means



Fig 260 —The incisions which may be used in removing innocent tumours of the breast

of a radial incision from the nipple (Fig 260) Such an incision does not damage the ducts which all converge on the nipple.

PART XV —OPERATIONS ON THE CHEST

EMPYEMA, THORACOPLASTY, DECORTICATION, LOBECTOMY, PNEUMONECTOMY, DRAINAGE OF THE PERICARDIUM PERICARDECTOMY, LIGATURE OF A PATENT DUCTUS, FOR CO ARCTATION OF THE AORTA, FOR FALLOT S TETRALOGY, FOR HYPERTENSION—THORACO LUMBAR SYMPATHECTOMY

TREVES AND WAKELEY CHEST OPERATIONS

Operation for empyema —The diagnosis of pus in the pleural cavity should be confirmed by an exploratory aspiration with a wide bore needle before proceeding to operation The nature of the infecting organism must be known since pure tuberculous empyemata must not be drained by a tube but by repeated aspiration Streptococcal pus thickens slowly and repeated aspiration must continue until the pus is thick before drainage is resorted to Pneumococcal pus thickens quickly and operation may be undertaken earlier when the lung will be adherent to the parietal pleura and total atelectasis (if not already present) will be avoided Some empyemata can be cured by aspiration and injection of penicillin if detected and treated early enough The majority need drainage eventually either by the insertion of an intercostal drainage tube as a temporary measure or most commonly by rib resection after thick pus has been obtained Disease in the underlying lung e g bronchiectasis, lung abscess or bronchial carcinoma must always be considered as a possible cause of the pleural abscess

Special instruments required for rib resection — A sharp curved pereosteal elevator is needed to strip perc from the rib a Doyen s rib raspatory to strip the

The submammary abscess is best opened towards the lower and outer side, but also at any spot where the pus points

The retromammary abscess is probably tuberculous and should be aspirated Later the diseased focus in the rib may require excision

sponge forceps The cavity may be inspected with the aid of a small chest light The cavity *should not be washed* out

Drainage of the empyema —A straight rubber tube of good calibre with no lateral openings should be inserted so that about 1 inch projects beyond the parietal pleura The skin should be sewn up loosely with one stitch through the tube and the tube fixed to the skin using a safety pin through the tube and thin strips of strapping through each end of the pin Vaseline gauze dressing makes the incision air tight If the lung is mobile the tube should be connected to an empyema bottle and the patient returned to the ward Inspiratory breathing exercises are done frequently and the tube cut short after a week or two and only removed when no empyema cavity remains as proved by injecting lipiodol into the tube and taking an antero posterior and lateral X ray

Comment —The tube must be inspected daily It may become blocked come out of the empyema or pass into the cavity if care is not meticulous The tube may impinge upon expanding lung or the pericardium if too long

THORACOPLASTY

This operation aims at collapse of the underlying lung by removing portions of the bony rib cage and is only used when other methods of collapse are impracticable or contra indicated It is most commonly performed for tuberculosis in the chronic stage in unilateral disease or to cure chronic empyema cavities or tuberculous empyemata The operation is done in stages the number *of ribs removed at each stage* depending upon the activity of the tuberculous disease In chronic empyemata the operation may be done in one stage It aims at concentric collapse of the lung

The patient is placed on the non affected side An incision is made from the second rib posteriorly and 2 inches from the mid line passing downwards and then forwards below the

surface of the rib and a ring cutter to sever the rib is convenient though not indispensible as straight bone cutting forceps will suffice in an emergency A pair of stout sequestrum forceps to grasp the rib is required A straight rubber tube and a sterile safety pin together with an aspirating syringe and an empyema bottle complete the necessary instruments

The position of the patient is important If the patient is coughing up his empyema shown by the presence of copious purulent sputum the operation should be performed under local anæsthesia with the patient in the sitting position so that pus cannot pass through his broncho pleural fistula into the opposite lung which may happen when he is lying on his sound side If he has no sputum the patient may lie in the lateral position near the edge of the table

The anæsthetic—local anæsthesia is usually sufficient and has the advantage that the patient can still cough up pus which may enter his bronchi A general anæsthetic may be necessary in children gas oxygen and trilene is usually sufficient

The site of the incision should be over the lowest point at which pus can be obtained by aspiration when the patient is on the operating table this is often over the ninth rib in the posterior axillary line The drainage should be dependant i e at the lowest point posteriorly of the pus pocket.

The incision may be parallel to the rib selected or vertical and about 2 to 3 inches long The muscle fibres over the rib are cut through the pereosteum over the rib incised longitudinally stripped off with a curved raspatory and the process completed with a Doyen s raspatory over a length of 2 inches thus protecting the pleura and intercostal nerves and vessels A ring rib shears is now used to cut each end of the expo ed segment of rib which is removed The presence of pus beneath the pleura at this site is confirmed by aspiration again and the pleura opened with a knife Pus is aspirated with a sucker, the optimum site of drainage confirmed by palpation of the cavity with a finger and any thick lumps of fibrinous material removed with

thene balls of 1 inch diameter Other substances used are sterile wax, and nylon gauze mesh The plombage space is closed with drainage after reuniting the cut posterior ends of the ribs The pleura is drained too if it has been inadvertently opened

The advantage over thorocoplasty is that no deformity occurs to the chest wall

Decortication

In the presence of a large hæmothorax or a large recent empyema the lung may be held in a collapsed state by a thick film of organizing blood or fibrin The visceral pleura always remains intact during the early stages of this process and the thick film may be stripped off the lung by gauze dissection thus allowing it to re expand It may also be stripped from the inside of the chest wall so that the intercostal spaces are not bound together by a plaque of fibrous tissue This operation is known as decortication and the freed lung is helped to re expand by applying motor suction through an apical and basal rubber tube placed in the intercostal space until the lung is fully expanded In selected cases the results are excellent The operation is done through an intercostal incision or after resecting a segment of one rib

Most important in the after treatment is vigorous coughing breathing exercises and posturing to keep the lung expanded and close to the chest wall Any dead space is liable to fill with blood clot which rapidly gets infected and renews the empyema

Lobectomy

Indications Chiefly for bronchiectasis confined to the lobe to be excised or removable by two lobectomies with or without removing diseased segments in other lobes

Causing artificial adhesions on the side to be operated upon has now been largely abandoned since the incidence of post-operative atelectasis has been found to be the same whether the pleura is adherent or not

The operation is done under general anæsthesia using

tip of the scapula to the anterior axillary line The muscles are cut through down to the ribs and the scapula retracted to expose the first rib A segment of the third rib is resected from the tip of the transverse process to the mid axillary line subpereosteally and is followed by resection of the second and the first rib in a similar manner care being taken not to damage the axillary artery and vein and the brachial plexus Almost the whole of the first rib may be removed

If the operation is being done for pulmonary tuberculosis the apex of the lung may now be mobilized by severing the fascial bands which anchor it to Sibson s fascia (Sebleau s bands) and stripping the parietal pleura and its fascia down wards from the apex the mediastinum and the chest wall even down to the hilum of the lung The wound is now closed in layers and at subsequent stages more ribs are removed if the collapse obtained at the first operation has not been sufficient

If the operation is done for a total empyema the tissues will be so adherent that an apical strip will not be possible If the empyema is loculated the removal of ribs over the *pocket itself may be sufficient to cure the disease* A decision on the extent of the rib resection needs fine judgment and experience

Plombage

This is similar to thoracoplasty in that the lung and pleura are stripped from the thoracic cage usually in the apical region to relax the diseased part Access is gained through a long postero lateral incision from the root of the neck following roughly the vertebral border of the scapula and then running anteriorly about 2 inches below the angle

The serratus anterior is divided from the chest wall with diathermy and the second and third ribs are divided posteriorly *The pleura is detached from the dome the upper 6 or 7 ribs* and the mediastinum and the lung retracted The inter costal bundles are divided posteriorly and sewn down over *the retracted* lung on to the tissues near the neck of the ribs

The free space above the lung is filled by about 20 poly

bronchiectasis and rarely for tuberculosis The operation is done under general anæsthesia sometimes with a one lung anæsthetic A continuous blood transfusion should be set up

The patient lies on the unaffected side with a cushion under the chest to separate the ribs on the side operated upon. An incision is made in the line of the sixth rib from a point 2 inches from the midline posteriorly to the nipple line and the underlying muscles severed with a knife in the line of the incision Usually the whole of the sixth or seventh rib is resected from the tubercle posteriorly to near the costo chondral junction anteriorly and the pleura is then opened If it is adherent it should be dissected free posteriorly until the hilum of the lung is reached Provided the condition is operable in the case of a carcinoma of the lung attention is now turned to the hilar structures These should be dis sected free and dealt with one by one In most cases the main bronchus should be freed first and clamped in order to prevent spilling pus or infected material into the other lung Afterwards the pulmonary artery and the superior and inferior pulmonary veins are dissected free carefully ligatured with strong thread and divided The lung is now removed and the bronchial stump closed with interrupted stainless steel wire sutures The pleura is loosely sutured over the hilar structures and the chest closed without drainage if bleeding has been minimal or with a tube connected to an empyema bottle and removed after forty eight hours if oozing of blood is occurring It is essential to know the detailed anatomy and variations of the hilar structures in order to perform this operation The phrenic nerve should be crushed in its course in the mediastinum before the chest is closed This aids in the obliteration of the large remaining cavity which is filled in by the ascent of the diaphragm displacement of the mediastinum some falling in of the chest wall and by fibrinous exudate which eventually becomes organized

Paracentesis and Drainage of the Pericardium

Paracentesis—The safest point to insert an exploring

cyclopropane and oxygen curare and a cuffed intra tracheal tube with facilities for aspirating pus from the trachea during the operation The patient is placed on the unaffected side with a support under the ribs and an incision is made along the seventh interspace *from the nipple line anteriorly* to the erector spinæ posteriorly The muscles of the chest wall are divided with a knife, and an incision made in the *intercostal* space keeping near to the upper border of the rib to avoid the intercostal artery The pleura is opened and a segment of the rib above is resected near the angle posteriorly and the intercostal bundle divided between ligatures The rib spreaders are then introduced and opened widely Adhesions between the pleural layers over the affected lobe are carefully divided with scissors and the structures in the hilum of this lobe are dissected free starting with the lower middle or upper lobe bronchus which is secured with a clamp as soon as possible This avoids expressing pus into the other lung during the process of removal of the diseased lobe The artery and vein supplying the lobe are then found and ligatured separately and divided The lobe is removed and the bronchus stump is closed by interrupted stainless steel wire sutures Air tightness is proved by covering the stump with fluid whilst the remaining lobe is inflated by the anæsthetist

If the inflation of the remaining lobe still leaves a large space in the pleura it is better to perform a small apical thoracoplasty to diminish this space rather than over inflate the lung This is most important if resection is being done for tuberculosis

The chest wall is closed with an apical and basal drainage tube which are both connected to underwater seals The apical tube allows any air which escapes from the raw lung tissue to escape and the basal one removes blood and serum If post operative atelectasis occurs despite breathing exercises *then the patient should be bronchoscoped and the affected* bronchus aspirated to relieve the obstruction of the lumen

Pneumonectomy

Removal of one lung is performed for carcinoma or total

of the treatment of the established disease in such patients An anterior incision through the second or third intercostal space dividing a costal cartilage above the incision provides sufficient access for most cases Sometimes a high postero lateral thoracotomy is employed

The mediastinal pleura is picked up immediately behind the phrenic nerve and below the aortic arch The ductus is

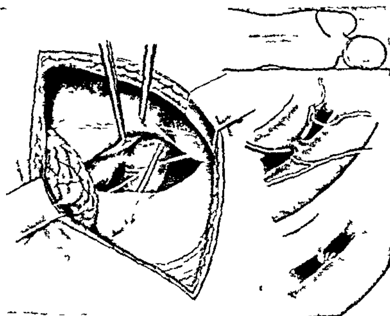


Fig 263 —Diagram showing the operative procedure for ligature of Ductus

exposed by dissection A thin fold of pericardium intrudes upon the ductus and has to be gently separated The recurrent laryngeal nerve has also to be avoided A blunt aneurysm needle is passed behind the ductus which is ligatured with two strands of silk A third strand is often placed by trans fixation midway between these two for additional security

needle is the left costo xiphoid angle The needle is kept close to the lower end of the xiphisternum and is directed upwards backwards and slightly inwards The pleura and internal mammary vessels lie laterally and will not be injured

The pericardium may also be tapped through the inner extremity of the fifth intercostal space close to the sternal margin

Drainage —The above exposure may be used for operations on the heart or a smaller opening used to drain a purulent pericarditis in which case the pericardium may be sewn to the skin

A good dependent point of drainage is obtained by making an incision parallel to and 1 inch below, the left costal margin near the midline and passing through the rectus abdominis down to transversus muscle and the posterior rectus sheath *This is detached by blunt dissection from* its origin from the back of the costal cartilages and the *central leaf of the diaphragm thus exposed is incised entering* the pericardium and avoiding the pleura A tube is placed up to the opening and sutured to the skin

Pericardectomy

In constructive pericarditis the patient s symptoms may be relieved in certain cases by excision of the constricting layer of fibrous tissue round the heart This may be done through an anterior incision as shown above or through a postero lateral thoracotomy incision which has the advantage of allowing more of the pericardium over the left ventricle to be excised In this operation it is imperative to decompress *the left ventricle first otherwise the increased blood* flow to the lungs following decompression of the right ventricle *cannot be carried away from the lungs and the patient will* die of pulmonary œdema

Ligature of a Patent Ductus Arteriosus

Ligation of the patent ductus arteriosus may be carried out to prevent sub acute bacterial endocarditis or as part

the aorta so that the aortic opening is situated above, (3) a defect in the membranous part of the interventricular septum, (4) the right ventricle is also grossly hypertrophied

Blalock has improved such patients by anastomosing the right subclavian artery to the right pulmonary artery

The incision is made in the right second or third interspace anteriorly in patients with a right-sided aorta and on the left side if the aorta is on the right The costal cartilage above may be divided to provide more room The pleura is opened and the mediastinal pleura divided behind the superior vena cava just above the hilum of the lung after ligaturing and dividing the azygos vein. The R subclavian artery is dissected free and divided just where it passes over the first rib The distal end is ligatured and the proximal end anastomosed end to side to the right pulmonary artery which is dissected free from the upper part of the hilum of the right lung The chest is closed without drainage Immediately after the anastomosis the cyanosis of the patient is markedly improved

Sometimes variations in the vessels used for the anastomosis are imperative for anatomical reasons

For Hypertension

Patients with malignant essential hypertension may be improved symptomatically and their blood pressure lowered by removing the sympathetic vaso constrictor supply to as large a number of arterioles as possible preferably including the splanchnic bed This operation was developed by Adson who excised the sympathetic chain below the diaphragm and then by Peet who excised the splanchnic nerves and sympathetic chain above the diaphragm These two operations were combined by White and Smithwick who excised the chain and the splanchnic nerves by a combined approach above and below the diaphragm as explained below

The patient lies on one side as for a kidney operation An incision is made vertically 2 inches from the mid line over the eleventh rib and passes downwards to the level of the twelfth rib then curving outwards just below this rib on to

against recanalization The thrill should disappear It is very rarely possible to divide the ductus with safety

For Co arctation of the Aorta

Diagnosis rests on the demonstration of hypertension in the upper half of the body and hypotension in the legs All degrees of co arctation from complete block down to a mere indentation of the aorta are met with and the site of narrowing is constantly found just below the point of entry of the ductus arteriosus into the aorta and just below the origin of the left subclavian artery

The patient is placed on the sound side and a postero lateral *thoractomy incision made* The *chest* wall *is* very vascular and the tissues may have to be held *in* broad clamps to control hæmorrhage from the collateral vessels round the scapula The pleura is opened and the co arctation exposed The grossly dilated intercostal arteries just above and below the site of resection are divided or controlled with small arterial clamps the aorta above and below the stenosed area is closed with rubber-covered clamps and the stenosis resected End *to* end anastomosis is now performed in two or three sections with a *running* everting mattress suture which *approximates intima to intima* all the way round The clamps are then removed and any leakage controlled with extra mattress sutures of oiled silk The chest is then closed with drainage *for* twenty four to forty eight hours after inflating the lung and the patient returned to bed Heparinization is not necessary and is in fact dangerous

For Fallot s Tetralogy

In cyanosed patients due to congenital anomalies in the heart and great vessels there are some conditions which can be benefited by improving the pulmonary blood flow by anastomosing a systemic artery to the pulmonary artery The chief of these deformities is Fallot s tetralogy which consists *of* (1) *pulmonary stenosis* (2) *Dextro* position *of*

operation is not performed under 21 years of age because of the risk of further attacks of acute rheumatism

The approach is through a left postero lateral incision through the fifth space The pericardium is opened about an inch posterior to the phrenic nerve The left auricular pressure and brachial systolic blood pressure are recorded by manometer

A curved Craaford clamp is placed across the auricular appendage being careful to avoid the descending branch of the left coronary artery The appendage is opened via a small incision whose edges are grasped by a small Duval s forceps The clamp is temporarily removed to wash out any thrombus in the appendage wall The finger is inserted into the auricle via the incision which is small enough to be plugged securely The auricle and valve are inspected digitally and the presence or absence of regurgitation which can be felt as a systolic wave is ascertained The anterior and posterior bridges of fusion of the valves are fractured by the finger Occasionally the valve has to be incised by a knife held on the finger (valvulotome) Every few seconds the finger is withdrawn from the valve orifice to prevent excessive periods of obstruction The aim is to widen the valve orifice without sacrificing any valve leaflet structure so avoiding regurgitation If regurgitation is found to be occurring the operation is abandoned An extensively calcified valve with a rigid orifice is often left without interference

The finger is withdrawn from the auricle at the same time as the auricular appendage is clamped The incision in the appendage is closed with interrupted thread sutures Pressure studies of the left auricle and brachial artery are again recorded The pericardium is loosely sutured and the chest is closed without drainage

In some cases it is impossible to approach the valve through the auricular appendage which may be too small or scarred from previous operation The left superior pul monary vein may be entered to reach the valve in these patients

the loin The muscles overlying the twelfth rib latissimus dorsi and serratus posterior inferior are incised the twelfth rib resected subpereosteally the external and internal oblique muscles and the transversus muscle incised just below the twelfth rib and the lumbodorsal fascia divided to expose the perirenal fat which is pushed forward exposing quadratus lumborum laterally and psoas medially The lumbar sympathetic chain is palpated with the finger in the groove between psoas and the vertebral column hooked up traced downwards as far as the fourth lumbar ganglion behind the common iliac vessels and resected The chain is then traced upwards through the crus of the diaphragm, dividing the medial arcuate ligament and exposing the pleura This membrane is stripped upwards off the chest wall and the vertebral bodies and the chain followed up into the chest as high as possible The splanchnic nerves are now found, traced downwards to the coeliac ganglion and resected together with part of the ganglion if possible and traced upwards as high as possible into the thorax where both they and the sympathetic chain are divided and removed The diaphragm is repaired and the wound closed in layers The pleura may be opened but this does not matter if positive pressure anaesthesia is being employed

The opposite side is denervated three weeks later by the same technique

This operation may owe part of its success to the fact that the *renal vessels lose their constrictor nerve supply* thus preventing cortical ischaemia which has been indicated by Trueta and Barclay to be a possible factor in hypertension

The same operation has been used to relieve pain in chronic pancreatitis when other measures have failed

FOR MITRAL STENOSIS

Mitral valvotomy promises to give long standing relief to patients incapacitated with mitral stenosis The most suitable cases for surgery are those with mitral narrowing causing symptoms of pulmonary congestion and limitation of effort Slight regurgitation is no contra indication The

PART XVI —TREATMENT OF VARICOSE VEINS

Before embarking on surgical treatment for varicose veins it is essential to prove that they are not secondary to a deep vein thrombosis The history will help here but in doubtful cases other tests are employed

(a) A rubber tube is used as a tourniquet around the upper thigh sufficient to obliterate the superficial veins The patient is made to walk about for a few minutes If the deep veins are obstructed there will be pain and severe congestion of the leg
(b) Phlebography may be done by injecting the external saphenous vein with diodone This will demonstrate the patency or otherwise of the femoral vein.

The aims of treatment of varicose veins are to remove as many veins as possible or to cause their thrombosis and then separate the deep from the superficial venous system

Trendelenburg's Operation —A 2 inch incision is made in the line of the saphenous vein, parallel to the inguinal ligament and as high in the groin as possible The easiest surface marking is to feel the pulsation of the femoral artery The femoral vein is just medial to this and the saphenous vein joins the latter vein anteromedially

The fascia is incised and the saphenous vein exposed There may be some difficulty because of large adherent lymph nodes around the saphenous opening especially if there has been leg ulceration There are usually three tributaries to the vein at this site—the superficial circumflex iliac, the superficial external pudendal (often accompanied by an artery) and the superficial epigastric The latter vein is the largest

A high proportion of these patients develop auricular fibrillation at some period in their convalescence and need treatment with digitalis and/or quinidine

Mitral Regurgitation has been successfully treated in some patients by turning down a pericardial flap to act as a new valve Up to now this has been a "blind" operation but with the advent of "dry heart" technique it should be possible to improve these procedures in the future

and cannot be secured unless the incision is as high as the fold of the groin

The main saphenous vein is only ligated when its termination into the femoral vein can be demonstrated There are often accessory saphenous veins which have to be secured

At intervals in the thigh and leg attempts are made to find communications between superficial and deep veins as can be seen under the skin as 'blowouts' These T shaped junctions are ligated Large tortuous masses of veins are best dealt with by excision

Stripping Operation—Multiple ligature of varicose veins is tedious and often leads to painful thrombosed segments of vessel, which gradually disappear

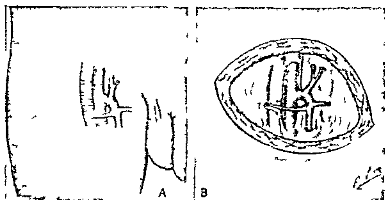
To obviate this many surgeons attempt to strip the whole internal saphenous trunk out Trendelenburg's operation is done as described A long wire stripper with terminal bulb is threaded down the vein from above until it reaches the ankle A small incision is made here and the vein exposed *and divided* The lower end is ligatured, whilst the bulb of the stripper is fixed to the upper end By firm pulling of the wire in the groin the whole saphenous vein may be avulsed from its bed and delivered in the groin wound To prevent bleeding a sterile bandage is wound firmly around the leg from below as the vein is removed

Comment—General anæsthesia is the best for these operations The groin wounds are difficult in healing owing to the natural *moistness of the area and the site of the incision* in a crease Local anæsthesia increases the likelihood of infection and is difficult to place accurately around the femoral vein

Retrogade injection of sclerosing solutions down the vein must be undertaken with great care as the catheter may penetrate a deep vein by mischance and there is a possibility of a bead of irritating solution being left in the groin wound as the catheter is withdrawn

It is best to avoid iodine as a skin preparation in any patient who has had varicose ulcer or eczema

All patients are made ambulant the day after operation to prevent the risk of deep thrombosis and embolism



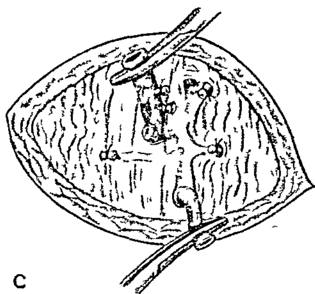


Fig 264 —Diagrams showing Trendelenburg s operation for varicose veins

A and B Anatomy of the saphenous opening C Internal saphenous vein and its tributaries ligatured

be accurately determined Co-operation between the surgeon, *radiotherapist and physicist is essential* The old way of inserting needles into a tumour in a haphazard way, and to express the dose as milligram hours is quite unjustifiable to day

Generally speaking tumours in which the cells have great powers of reproduction are radio sensitive while tumours in which the cells are highly differentiated are radio resistant Unfortunately radio sensitivity does not mean curability It

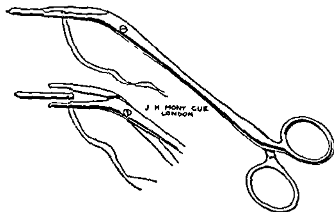


Fig 265 —Wakeley s radium applicator forceps

is also true that if the primary growth is radio sensitive the secondary growths are often very radio resistant

Radium needles contain as a rule 0 5 mgm of radium element to every centimetre of active length of needles they have an internal diameter of 1 millimetre and the walls are 0 5 millimetres thick. Radon seeds have a standard length of 0 65 centimetres and the radon is screened with 0 5 millimetre of gold Sterilization is *effected by boiling for* 20 minutes

METHODS OF USING RADIUM

1 ***Cavitary method*** —This is applicable for the treatment of carcinoma of

The mouth

PART XVII —RADIUM AND ITS USE IN THE TREATMENT OF CANCER

RADIUM is an element and the salt of radium which is used therapeutically is the sulphate This gives three types of rays

(1) Alpha rays, which are positively charged helium atoms
(2) Beta rays which are similar to the cathode rays generated by an X ray tube
(3) Gamma rays which travel with the velocity of light and which are destructive to the cancer cells

It is essential to screen the alpha and beta rays in order that the gamma rays may exert their penetrating effects and this is done by enclosing the radium in a platinum container This container may take the form of a needle if it is to be buried interstitially or of a plaque if it is to be applied to the surface of the body

Radium gives off the gas or emanation which is called radon and which is of therapeutic value The amount of radon which is in equilibrium with 1 gramme of radium is called a curie This is a large unit for therapeutic purposes and the millicurie i e 1/1000 part of a curie is generally employed Radon loses one half of its therapeutic activity in 3 85 days whereas the activity of radium element undergoes no depreciation The dose of radiation is the amount of energy absorbed at a given point The basis of measurement is the ionization produced in air and the unit of quantity of radiation is the roentgen (r) The amount of radium required and the way it should be arranged in each individual case to give a prescribed dose uniformly throughout the volume of tissue can

from teeth which are healthy, as they set up secondary radiations which may be harmful

Malignant growths of the tongue are treated by burying radium needles around the growth and beneath it at regular intervals and the needles are sewn into position, as shown in Figs 266 267 Generally speaking needles containing 1 5 or

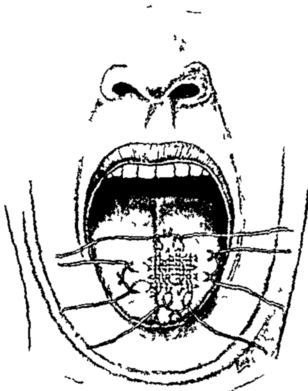


Fig 267 —Carcinoma of the tongue with radium needles *in situ*

2 milligrammes of radium element will be employed and the distance between them should be approximately 1 centimetre For growths involving the posterior third of the tongue radon seeds are more convenient

The rectum
The vagina

The needles are held *in situ* by embedding them in specially made holders and are supplemented by needles buried in the growth This method lends itself admirably to growths in the palate and cheek

2 **Interstitial method** —Introduction of needles into and around a growth

3 **Surface application** —Radium is applied to the surface of the body either by means of a thickness of 15 milli metres of sorbo rubber or Columbia paste (beeswax paraffin wax, and sawdust) or cotton wool It is usefully employed in the treatment of

(a) Malignant glands of the neck
(b) Rodent ulcers on the face
(c) Nævi

4 **Distant method** —For this purpose a radium bomb is employed This consists of a massive dose of radium varying from 1gramme to 15grammes radiations from which are brought to bear upon the growth from a distance

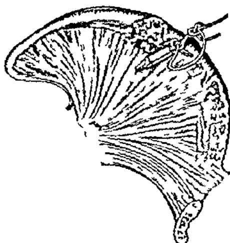


Fig 266 —Radium treatment of the tongue showing the insertion of a radium needle

DETAILS OF TREATMENT

Tongue and mouth —Before radium can be inserted into the mouth great attention must be paid to oral hygiene Decayed teeth are removed infected ulcers are healed and it is often advisable to remove metal stoppings

may be treated by block dissection, radium collar, or the bomb"

Larynx.—This is treated by the fenestration method, a piece of the thyroid cartilage being resected radium needles placed side by side are inserted into the window thus avoiding necrosis of the cartilage As this frequently results in considerable œdema of the glottis, preliminary tracheotomy is usually advisable

Breast.—The introduction of interstitial radium needles for treatment of breast cancer as practised by Keynes has been abandoned

Removal of the breast by simple mastectomy followed by radiotherapy to the axilla has had good results in some hands (McWhirter)

For tumours of the inner quadrants some surgeons place a radium needle in the upper four intercostal spaces in the parasternal area at the same time as doing radical mastectomy

MAXILLARY ANTRUM.—Excision of the upper jaw for carcinoma of the antrum is a mutilating procedure

As good results are obtained by a combination of radiation and surgery

A hole is made in the hard palate to allow diathermy excision of most of the tumour and afford drainage of the usually infected cavity The interior of the antrum can then be irradiated via the fenestra by means of a plaque of radium or radon carried on an obturator fixed to a denture Alternatively a radium or radon source can be fixed in the centre of the cavity to irradiate its walls

Anus.—Growths of the anal canal are radio sensitive if arising from squamous epithelium and the prognosis is relatively good Needles are employed rather than seeds and have to be inserted into and around the growth and sutured in position by means of silk brought out through the skin It is necessary to keep the bowels constipated for 5 or 6 days and the needles are removed under gas anæsthesia The reaction from the radium is usually painful and severe and may be delayed for 3 weeks It is not necessary as a rule to perform a preliminary colostomy If glands are secondarily

Glands of the neck which have become involved secondarily should be treated either by block dissection or by a radium collar 6 weeks after the primary growth has been treated

The Wassermann reaction should be taken in all cases and if it is found to be positive, treatment by iodide of potassium is instituted

Palate and tonsil —The same precautions are taken to ensure oral hygiene before, during and after treatment Radon seeds each containing 2 millicuries with 0 5 millimetre gold screening are inserted, by means of a special introducer (Fig 268) outside the clinical limits of the growth at a distance of 1 centimetre from one another

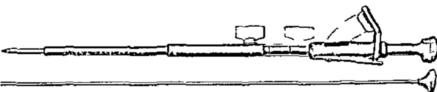


Fig 268 —Radon seed introducer

Glands of the neck are treated after one month as outlined above

In irradiating the tonsil it may be advisable to resect the angle of the jaw in order to avoid bone necrosis

Lip —Surface irradiation may be carried out by means of suitably moulded plaques 1 millimetre of sheet metal being used to protect the teeth and the alveoli but generally speaking interstitial radiation is preferable Needles containing 0 5 milligramme of radium element in 0 5 millimetre of platinum are inserted around and under the growth and tied in position If the growth is of the hypertrophic type it should disappear in 6–8 weeks but if it is of the infiltrating type it will take considerably longer

In cases in which radium treatment fails excision must be performed

Glands in the neck are not involved if treatment is commenced early, but late cases with secondary involvement

PART XVIII —SKIN-GRAFTING

The necessity for skin grafting after deep burns and traumatic injuries involving a loss of skin has increased owing to modern warfare

Six different degrees of burn were described by Dupuytren and his classification may still be retained, as it is universally known (Fig 269)

The *first* degree consists merely in a scorch or superficial congestion of the skin, without destruction of tissue the part may for a time remain red painful, and prone to ulceration

In the *second* degree the cuticle is raised from the cutis and a bleb or blister results When this bursts and the cuticle is removed the cutis vera red and painful is exposed below

In the *third* degree the cuticle is destroyed as is also part of the cutis vera but the tips of the interpapillary processes including the exquisitely sensitive nerve terminals are laid bare and left intact consequently this is a most painful form of burn The deep structures of the skin viz the sweat and sebaceous glands and the hair follicles are not destroyed Although the surface during the healing process becomes covered with granulations the integument is very rapidly replaced since there are so many surviving epithelial elements from which it can grow The cuticle is able to form not only from the edge as must occur whenever the whole of the cutaneous envelope is destroyed but also from innumerable foci scattered over the wound surface

In the *fourth* degree the whole thickness of the integument is destroyed as well as part of the subcutaneous tissues In the *fifth* the muscles are involved whilst in the *sixth* the whole limb or other affected part is completely charred and disorganized In the last three forms healing can occur only by

involved in the inguinal region they are best treated by block dissection although this may cause œdema of the lower limb If fixed radiation by bomb is preferable

Cervix uteri —Treatment by radium has replaced all other methods in this situation and, while the technique varies considerably in the different clinics yet one principle remains the same i e to attack the growth from within the cervix by means of radium inserted into the cervical canal in a lead applicator and from without by means of appropriately fashioned applicators which are placed in the vagina in the lateral fornices *In this way the growth is subject* to a cross fire and the results are on the whole very satisfactory

Carcinoma of the body of the uterus on the other hand *does not respond favourably to radium treatment and surgical* removal is still the method of choice

Radium Treatment in Cases of Sarcoma

There is such wide variation in radio sensitivity in sarcomata that it is difficult to discuss their treatment by means of radium In the case of growths which are radio sensitive and in which removal is impossible the course to be adopted is clear Such cases include lympho sarcoma in glands and sarcoma of the upper air passages in which radiation is the only available method of treatment Osteogenic sarcoma and fibro sarcoma arising in soft tissue have an unfavourable prognosis A less gloomy outlook has arisen in recent years however after trials of treatment with a combination of radical surgery and external irradiation Radiation almost invariably fails to benefit sarcomata of the melanotic type and wide excision is the treatment of choice in these cases

Skin grafting, or the transplantation of more or less of the thickness of the skin from a healthy to a healing part, was introduced by Reverdin in 1869, and has since been much elaborated and is employed for large or small surfaces

The following are the chief methods employed

1 Transplantation of small pieces of the cuticle and cutis, Reverdin's original plan A small portion of the cutaneous tissue is pinched up, with or without forceps and removed by a knife or sharp curved scissors It should include the cuticle and a portion of the cutis vera so that a drop or two of blood will slowly ooze from the denuded surface The graft is gently placed cutis (i e deep) surface downwards on the surface of the granulations and covered with sterile protective Many such "pinch" grafts may be applied at the same time

2 Transplantations of large portions of cuticle as suggested by Thiersch This method consists in removing strips of cuticle, up to 4 to 5 cm square, with a razor, and implanting them on a fresh wound or on a raw surface denuded of granulations by scraping all hæmorrhage must be previously stayed by pressure In cutting the strips of cuticle care must be taken to make them as thin as possible the papillæ are always encroached on, however, and hence some amount of blood escapes in which the grafts are allowed to remain soaking until required for use The grafts are applied in such a way that they overlap each other and also the margins of the defect

3 The whole thickness of the skin is used in some instances (Wolfe graft) The graft is cut rather larger than is necessary to allow for shrinkage and all subcutaneous tissue and fat removed therefrom It is applied to the raw surface of the wound after scraping away all granulations and stitched into position It may also be

removal of sloughs and the formation of a cicatrix, and therefore early skin grafting is essential

From a practical standpoint it is easier to divide burns

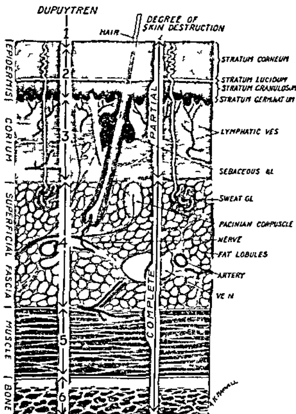


Fig 269 —Diagrammatic section through the skin showing the degrees of destruction according to Dupuytren s classification and the more modern method

into two classes (1) those which involve partial skin loss (1st 2nd and 3rd degree burns) and (2) those which involve total skin loss (4th degree burns or deeper) (Fig 269)

not only to cover raw surfaces but also to build up parts that have been destroyed as in plastic oro facial surgery It is impossible here to discuss this procedure in detail, but as an illustration of its utility may be mentioned the covering of a surface after a burn over the front of the elbow joint where movement would be much restricted by the development of an ordinary scar In such a case a pedicle flap should be raised from the lateral abdominal wall and stitched in position to the arm which is suitably fixed by plaster or bandages to the side when union has occurred the pedicle is divided and the arm set free

To sum up it may be said that the Thiersch graft is more often cut too thin than too thick. The essentials for success are asepsis, perfect hæmostasis perfect application immobilization of the graft to the part so that no slipping of the graft can occur and the constant application of gentle pressure for a few days to prevent accumulation of serum or blood under the graft

The same rules apply to the Wolfe graft with the added caution that if the graft be subjected to abnormal lateral tension (whether it is too tight too loose, or too great pressure is applied) it will probably die

applied directly to an operation wound, when the edges cannot be brought together

The *sieve graft* is in reality a modification of a Wolfe graft and certainly is popular to-day, and is used extensively for covering the exterior surfaces of the hand or foot After cutting the graft about a quarter of an inch larger than the area to be covered the graft is placed on a swab and several incisions going through the whole

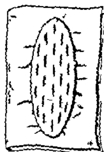


Fig 270

Incisions made into Sieve Graft

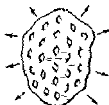


Fig 271

Sieve Graft ready for transplanting

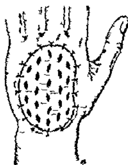


Fig 272

Sieve Graft applied to the back of the hand

thickness of the graft are made (Fig 270) The graft is then stretched over all parts of its circumference (Fig 271) and finally is stitched over the raw area (Fig 272) The openings allow escape of serum and so the graft is always in apposition to the tissue beneath it

4 Unfortunately the complete detachment of the flap associated as it is with complete severance of the blood supply is often followed by loss of vitality and to avoid this accident pedunculated flaps (pedicle grafting) are now employed,

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PART XIX —LIGATURES AND SUTURES

It would be appropriate here to list the various materials at the disposal of the surgeon for purposes of ligature and suture with a brief description of their usage.

Absorbable Sutures

Catgut —This is made from the submucosa of the sheep intestine and is available in various gauges and degrees of hardness. Its quality is now uniformly standardized and its sterility assured. It is stored already sterilized in sealed tubes which are kept in pure ... and cannot be boiled. To increase its toughness it is hardened in chromic acid. It is labelled 10 20 and 30 day according to the time it takes to disintegrate in rabbit's muscle. It must be pointed out that in the stomach or intestine 20 day catgut disintegrates in 3 to 5 days.

Nearly all surgeons use catgut for operations on the stomach urinary bladder and bowel and for uniting peritoneum. Its use elsewhere is often a matter of personal preference.

Contrary to what is generally supposed plain catgut produces a much more intense tissue reaction around it than does the hard.

One of the disadvantages of catgut is that its tensile strength in relation to thickness is not great and that the knots are bulky and tend to come undone.

Kangaroo Tendon —This is very strong slowly absorbed material produced from the tail of the Wallaby. It is very rarely used now since it has been replaced by no... sutures

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its short length It is however easy to tie and is tough. It can be used in the skin for example in the scrotum

It has been mainly superseded by nylon

Other Materials

Stainless Steel can be used either braided or plain It is sterilized by boiling and is completely inert It is difficult to tie and the knots may cause trouble if too near the skin A special pair of scissors must be kept to cut it It is invaluable for uniting bone fragments where it has replaced silver wire It is useful for suturing the abdomen where disruption may occur—in intestinal obstruction or in an emaciated patient

Tantalum may be used as wire or as gauze It is completely inert but is very expensive It is sometimes used as a scaffolding in the repair of large hernial defects

Clips—Nickel and Kifa clips are used to unite the skin. They are easy to insert and give good apposition They will not hold if the wound is under tension They are often used in the neck where union occurs rapidly and hence they can be removed in 3–4 days

Horsehair—The best material is made from the tails of black Spanish horses but it has been largely replaced by synthetic fibres It is thin elastic, and tapering and not of uniform colour It is therefore difficult to tie It is sometimes used for fine facial suture

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